MASTER OF SCIENCE IN
STRUCTURAL ENGINEERING

Course Curriculum

Mid-West University (MU)
Graduate School of Engineering

2022 (Revised)

Mid-West University (MU)
Master of Science in Structural Engineering Program

1. Background

Nepal is landlocked mountainous country with its all worlds' tropical and geographical variation throughout the country. Nepal is still lagging behind for its infrastructure development to access each part of country ranging from east to west and north to south. Since Nepal has long range of variation on its geographical, geological and tropology, it needs high skilled engineers who may keep capacity for design, construction and developing new engineering materials and technologies for the country.

With the political settlement, Nepal Government from now should start various national pride large and mega projects like hydropower, tunnels, international airports, highways etc. in the country. Nepal has a very big potential for its tourism business development in various parts throughout the country. Private sector has also started to invest for various infrastructures like luxury hotels, cable cars, hospitals, academic institutes, high-rise apartments etc.

However, Nepal now is still dependent on foreign designers, consultancies, contractors for medium and large infrastructure developments. It is because of following deficiencies which had to be solved ourselves.

1.1 Lack of high skilled structural engineers

It is bitter truth that we are still lagging for conducting graduate studies in different field of engineering with high level of product-oriented research works. Due to this reason, most capable BE engineers go overseas for their ME/PhD study for their graduate study. Due to having less opportunity in Nepal, most graduated engineers have not returned to Nepal and engaged in different parts of world for their academic and professional career development. Due to it, Nepal is still dependent upon foreign designers, consultancies and construction companies for the implementation of medium and large infrastructures development. Due to lack of high skilled structural engineers, Nepalese consultancies and construction companies are still not capable to handle the design and construction of big projects. In other side, although engineering colleges and graduated engineers are increasing year by year in quantity, we are still unable to produce capable engineers in terms of quality due to not having high skilled structural faculties. Another serious matter is that pass percentage of students in each engineering college is very less and most are noticed failing in structural related subjects. With above consideration in both academic and professional fields, Nepal needs high skilled structure engineers for both academic and professional fields.

1.2 Lack of Quality Control in Construction

We Nepalese engineers are somehow capable in design works but very poor in quality control of construction due to various reasons. Nepalese people spend huge amount of money for the erection of their residential buildings. However, they are not made any aware by any means to secure if their houses are strong in sense of strength, serviceability and durability. After Nepal Big Earthquake 2015, Nepalese concerned authorities have made strong rules and regulations for providing building permission. Even now, quality control of construction solely depends upon non-engineer contractors who have less knowledge about the adoption

of quality control ranging from selection of materials, storage, mix design, batching, mixing, transportation, placing, compaction, finishing and curing. Moreover, no any systematic system has been made in concerned authorities to have strict inspection in quality control for each step of construction work in real sites. It is only due to lack of engineers in authorities who may keep command in materials, structures and quality control.

1.3 Lack of Locally Developed Cheap Construction Materials and Technologies

It is fortunate that Nepal is self-dependent for the basic construction materials like cement, water, fine aggregates and aggregates. Although clinker of cement is still imported from India, effort is made to produce it in the country. With modernization in construction industries various new sophisticated engineering technologies and materials have been developed in the world. Very less effort has been made to develop such technologies in Nepal using local materials. Instead, such technologies and materials have been imported by businessmen without any secure on quality control either by producer or concerned authority.
Few attempts are made to develop and standardize new engineering materials/products from local raw materials in Nepal. This trend is extremely increased after Nepal Big Earthquake 2015.
From now on, we have to be concentrated to develop basic new engineering technologies and materials ourselves using our own local materials which can be upgraded and enhanced through the joint-research work with foreign academic/business institutes. Such activities may provide us chance taken to create the appropriate plate form for the "**Technology Transfer**" in universities/engineering colleges. With such development, monopoly on importing low quality of construction materials/products will sharply be decreased, if not eliminated.

1.4 Poor Academic Performance

Engineering universities/colleges are the main backbone for the infrastructure development of the country. However, all engineering colleges in Nepal are mainly concentrated theoretical academic functions rather than practically enhancement for bachelor in civil engineering students. Our colleges are still lagging behind to develop research products which may be vitally important for the infrastructure development of Nepal. Although some engineering master programs are running in different engineering colleges, their thesis products have not been able to meet the demand of country. Some engineering colleges have started to publish yearly engineering journals, their impact factors are not recognized yet. Very few experts publish their papers in international journals or present in international seminar proceedings.Some PhD candidates who initially to proceed their study in Nepal have been bound to go to foreign universities due to lack of appropriate guidance from experts. It is therefore Nepal is almost ranking at bottom for its research and development works in civil engineering fields.

1.5 No Plate Form for Internationally Recognized Nepali Experts to Return

China and India are tremendously concentrated on world patented research and development works. Initiation of the development work was only possible after the return of their experts to their respective country and creating the platform for the joint research and development work. Nepalese engineers (experts) who are spread over different parts of the world are also wishing to Nepal to serve in their respective engineering field. For it, we have to create the

platform for their return with start of basic research and development works in each university/college.

1.6 Building Codes

Nepal Building Code (NBC) is still in preliminary stage with respect to all engineering aspects. It has done progress in masonry structures and seismic design requirements. However, we still should rely on Indian, British or American codes for any sort of structural designs. Moreover, it has not touched yet on the quality control of materials and construction procedures. A lot of research work, both on experimental and analytical part, and experts in different fields are needed to complete it.

2. Program Objectives

The developing country like Nepal seeks infrastructural developments tremendously and civil engineering skilled manpower is required in large scale to fulfill the requirement. This program will equip students with the advanced knowledge and skills to succeed in this challenging industry. You'll build your knowledge of a range of core topics such as concrete and steel design, structural analysis, design optimization and how structures are designed and managed in earthquake zones. You'll also develop your research skills and focus on a specific topic when you complete your own research project. Most of the civil engineering projects include development of various structures in almost all the fields, like in water supply, hydropower, irrigation, transportation, environmental works, building construction etc. The structural engineering is necessary to design almost all kind of objects required for civil engineering projects and the country at present includes structural engineers in less in numbers. In this regard, the country like Nepal, which is moving ahead in lot of constructive works in the field of civil engineering essentially, requires huge number of structural engineers at the present context of Science in Structural Engineering (M.Sc. STR) program focuses in providing a practical field domain capability to each student that allows them to have a meaningful career in structural analysis, design and construction, deals it with making earthquake resistance , safe and economic and as well in industrial and in academic fields. The taught units provide an introduction to experimental work and research methods and cover advanced aspects of theory and design principles relevant to the static and dynamic behaviour of structures, steel and concrete structures and finite element modeling. A particular highlight of the taught component of the course is studying the behaviour and design of structures against extreme loading including fire and earthquake, which is taught by internationally leading researchers and engineers. As a large multi-disciplinary engineering school, MACE has academic staff who are experts in a broad range of research areas and have a wide spread of professional experience in industry. The course offers several optional and self-contained modules in the field of Structural Engineering. Different areas, such as structural analysis of building structures, bridges, design in various types of steel and concrete structure, dynamic analysis of structures, earthquake engineering, soil structure engineering, dam structure , water retaining structure , thin plate and shell structures are covered through the optional modules of this program. The specific objectives of the program are as follows:

- Provide students with experience and skills for multi-disciplinary practices related to structural analysis
- To provide knowledge in depth and understanding of the complex structural behavior and design of different types of structural forms and materials.

- To develop practical knowledge and self-directed in solving problem and able to act autonomously in planning and implementation with leading tasks at a professional level in structural Engineering with full knowledge of software used in structural Engineering.
- To carry out independent research in a topic related to structural engineering.
- To develop innovative skill for modern structures like rotating tower, thin shells and other complex structure

3. Curricular Structure

Resiliency (the capacity of withstanding exceptional loading events such as unintentional overloading, hurricanes, earthquakes, and man-made hazards) and sustainability (the ability of being durable, reliable, and economical affordable during the entire life-cycle) are the two main issues at the forefront of modern civil engineering and the curricular structure must related to those. The curriculum is designed to enhance students with the competencies, knowledge, skills, and innovative (practical) attitudes needed for success in structural positions. The coursework gives students a broad and all-inclusive view of the complexity of technologies concerning different structural analysis and design in modern world. The curriculum comprises the following distinct components. This course offers advanced training in the analysis, design and construction of structures in a variety of materials.

- **Core Courses:** The core courses provide students with the idea and concept of analytical and design parts during **3** semester such as in advanced structure analysis, dynamics of structure, prevailing concept in earthquake resistance design, Bridge analysis and design, Finite element method, Solid Mechanics, Advance concrete technology, Advance Geotechnical Engineering, Advance structural design and familiar with international codes of practices and use of advance software.

- **Elective courses:** The student is required to take five courses of three credit hours as electives of which specialization must be outside of core courses. The objective of elective courses is to provide flexibility to the students in selecting course in which they have special interest leading guidance for the thesis.

- **Seminar**: The student is required to undertake seminar –I, II, III work prescribed by Mid-West University. The objective of seminar is to provide students motivation participating and presenting their skill before submit thesis work. This course covers **8** credit hours

- **Thesis**: Students are required to undertake a graduate research that involves site visit, data collection with proper methodologies and innovative analysis of the information collected. Students are also required to prepare a research thesis on a prescribed format. This course covers **12** credit hours. The dissertation provides students with an opportunity to gain practical and innovative experience of the research for a period of eight months. Adequate guidance of supervisor and students' performance will lead innovative or modified thesis report. **The publication of article related to thesis work in any national/international journal by individual students will be kept as mandatory prior awarding the degree.**

4. Program Features

The features of the program are competitive learning environment, innovative research-driven concentrations, and program certainty using various program. The M. Sc. in Structural

Engineering is a two-year program covered in four semesters. A student needs to successfully complete **75** credit hours of course work. Students also undertake Dissertation during the third & fourth semesters. In third semester students initiate proposal defense and in fourth semester they will fully engaged in midterm and final presentation of thesis report.

The regular M.Sc. in Structural Engineering program is to be completed within four semesters. The duration of each semester will be **12** weeks excluding examinations period. It can be run with a greater degree of flexibility as per rule of campus and Dean office. It may be run on full-time schedules. The concerned campus may choose a modality to run the program.

5. The Semester System

In the program, each course has a certain number of credits assigned to it depending on its lecture, tutorial and practical work hours in a week which was verified and assigned by subject committee and Academic council of the **Mid-West University (MU).** For a theory course, a **3** credit hours course has **45** hours in a semester. For a practical (Laboratorial) courses it may be assigned as two-third of theoretical course; will depends upon approval by subject committee.

The specific features of the semester system are the process of continuous evaluation of a student's regularity and performance; the flexibility will be allowed to the students for progress at a pace suited to his/her individual ability, class performance, subjected to the regulation of credit requirements.

6. Entry Requirements and Admission Procedures

➢ Eligibility Criteria

Admission to the above program shall be made subject to the eligibility, qualifications and specialization prescribed by the University for each program, from time to time.

Degree of Bachelor of Civil Engineering and equivalent is eligible to admit in the program. Also, the applicant must have along with the above criteria a minimum of 16 years formal education (12 years of schooling plus four years of Bachelor degree). The applicant must have secured a minimum CGPA of 2.0 or equivalent at the Bachelor degree level recognized by TU. The final decision on admission is taken on the basis of scores on the admission test, group discussions and interviews.
Admissions shall be made on the basis of merit rank obtained by the qualified candidates at an Entrance Test conducted by the University
Have undergraduate grades significantly above average and not less than the prescribed (minimum CGPA of 2.0 or equivalent at the Bachelor degree level) by the faculty board of Dean Office, MU.

- Equivalent degree as the same kind of degree obtained from institutes other than MU and recognized by TU as the equivalent to the degree provided by TU in the same discipline.

➢ Required Documents

The applicant is required to submit the following documents with the application form made available by the concerned college by paying a predetermined fee:

- Citizenship certificate
- Curriculum Vitae (CV)
- Registration certificate from Nepal Engineering council.
- Completed and signed application form

- Official transcripts from all the academic institutions attended.

Certificates of all degrees should be photocopied and submitted with proper attestation. Enrolment is conditional upon completion of all admission formalities including payment of The candidate should deposit required amount as an application fee for entrance examination in Account No mentioned in the notice by submitting a specially prepared voucher often by filling applicant's name and date of birth in it. The voucher No. indicated in the voucher needs to be specified in the application form; determined by the college and the original certificates must be shown before proceeding of enrollment. Incomplete applications shall not be processed.

- **Admission criteria and selection procedure**

A notice inviting applications for admission will be publicly announced through daily national papers of Nepal and also through Website of **MU**. Application forms and information brochures are provided, on request, after the payment of the prescribed fee by college. The concerned college scrutinizes the application. The eligible candidates will be informed to take the entrance test which will be held through Dean office. The date and time for the entrance test are informed to the applicants by the coordination of concerned colleges concerned with Dean office.

Final selection of students and merit list will be made on the basis of their aggregate scores in the entrance test, experience and their previous academic records. A college may, however, modify the selection procedure to suit its needs with prior approval of the Dean.

The candidates, who are given provisional admission under special condition, are required to submit all necessary documents verified with original documents by academic authorities within a month of the beginning of regular classes. Otherwise, the admission will be canceled.

7. Course work:

- A Candidate after securing admission must pursue the MSc. Structure course of study for Four semesters duration.
- Each semester shall be of 20 weeks duration or prescribed duration as per academic calendar including all examinations.
- A candidate admitted to a program should complete it within a period equal to twice the prescribed duration of the program from the date of admission.

8. Academic Schedule and Course Registration

The academic session consists of four semesters. However, admission to the program will only be given once a year as per the schedule published by the college. Students are required to register courses at the beginning of each semester. Since registration is a very important procedural part of the credit system, all students must present themselves at the college for registration which will be approved by college with coordination of Dean Office and central exam committee of **MU**. Registration in absence may be allowed only in rare cases at the discretion of the campus chief. A student's nominee cannot register for courses but will only be allowed to complete other formalities.

9. Addition and withdrawal from Courses

A student would have the option to add or drop from the course. This can, however, be done only during the first week of the semester. A student wishing to withdraw from a course, should apply on the prescribed from within two weeks from the starting date of the semester. A full time student has to take a minimum of **12** credits in a semester.

10. Attendance Requirements

The students must attain every lecture, tutorial and practical class. However, to accommodate for late registration, sickness and other such contingencies, the attendance requirements will be a minimum of **75%** of the classes actually held. Students will get NOT QUALIFIED (NQ) status if s/he fails to maintain **75%** attendance in any course.

- A candidate shall be deemed to have eligibility to write end semester examinations if he has put in at least **75%** of attendance on cumulative basis of all subjects/courses in the semester.
- Consideration of shortage of attendance up to **10%** i.e., from **65%** and above and less than **75%** may be given by the college on the recommendation of the campus chief in special cases.
- Consideration of shortage of attendance shall be granted only on genuine and valid reasons on representation by the candidate with supporting evidence.
- If the candidate does not satisfy the attendance requirement, he is detained for want of attendance and shall reregister for that semester. He/she shall not be promoted to the next semester and students will get NOT QUALIFIED (NQ) status.

11. Normal and Maximum Duration of Study

The normal duration and the maximum duration for the completion of the requirements for the various programs are as follows:

Normal duration: 24 months (4 semesters)
Maximum duration: 24 months from the date of registration.

(All the courses have to be completed within 4 years, and additional 1 year can be given to thesis work on special request upon the approval of Dean's office)

12. Evaluation System

The performance of the candidate in each semester shall be evaluated subject wise, with a maximum of **100** marks for Theory and **100** marks for practical, on the basis of Internal Evaluation and End Semester Examination**.**

- For the theory subjects **40%** of the marks will be for the External semester End Examination. While **60%** of the marks will be for Internal Evaluation, based on the better of the marks secured in the two Mid Term-Examinations held, one in the middle of the Semester and another immediately after the completion of instruction.
- For practical subjects, 100 marks shall be for internal evaluation based on the day to day performance of practical works.
- For Seminar there will be an internal evaluation of 50 marks. A candidate has to secure a minimum of 50% to be declared successful. The assessment will be made by a board consisting of HOD and two internal experts at the end of IV semester instruction.
- A candidate shall be deemed to have secured the minimum academic requirement in a subject if he secures a minimum of 60% of marks in the End Examination
- In case the candidate does not secure the minimum academic requirement in any of the subjects. He has to reappear for the Semester Examination either supplementary or regular in that subject, or repeat the course when next offered or do any other specified subject as may be required.

A student's academic performance in a course is evaluated in two phases as:

- **Internal-evaluation**- Internally by the related faculty member and

- **External Evaluation**- Externally by the Dean office through External-semester-end examinations.

In Summary a sixty percent weight is given to internal evaluation and forty percent weight is given to external evaluation. The pass mark for both the internal evaluation and external evaluation is sixty percent. A student must qualify in both evaluations separately to get a pass grade in a particular course. The final grade awarded to a student in a course is based on his/her consolidated performance in both internal and external evaluations.

The internal evaluation may consist of various components like project works, presentations, written examinations, reflection notes preparation, and class performances. A student will get NOT QUALIFIED (NQ) status in the internal evaluation if his/her performance falls below the minimum requirement. Such students will not be allowed to appear in the semester-end examination of that particular course.

13. Grading System

MU will follow a four-point letter grade system. The letter grades awarded to students will be as follows:

Letter	Range	Grade	Grade Point Description
A	85-100	4.0	Outstanding
A^-	80-84	3.67	Distinction
B	75-79	3.33	Excellent
B^-	70-74	3.00	Very Good
C	65-69	2.50	Good
C^-	60-64	2.00	Average
D	55-59	1.50	Fair
D^-	50-54	1	Satisfactory
F	Below 50	0	Failing

The performance of a student is evaluated in terms of two indices:

- Semester Grade Point Average (SGPA) which is the grade point average of the particular semester, and
- Cumulative Grade Point Average (CGPA) which is the grade point average of all the semesters.

$$SGPA = \frac{\text{Total honor points earned in a semester}}{\text{Total number of credits taken in a semester}}$$

where,

Honor Point = Grade point earned in a subject × Number of credits assigned to that subject

14. Degree Requirements

To graduate from the M.Sc. Structural Engineering program, a student should have

- a 'C' or better grade in each of the courses as specified in the curricular structure section;
- completed all the courses, seminar and research project work as specified in the curricular structure section within the maximum time period specified in the normal and maximum duration as per academic calendar of the University;
- a final CGPA of 3.0 or better on the University's maximum 4.0 grade scale.
- good character maintained during full study period of MSc. In Structural Engineering.

- submission of thesis work and **publish of minimum 1 article** related to thesis work in any international journal.

15. Distinction and Dean's List

A student who obtains a CGPA of 3.75 or better will receive the M.Sc. in structural Engineering with distinction. The Dean's list recognizes outstanding with Excellency academic performance in the program. To qualify to this list, a student must have a CGPA of 3.80 or better.

16. Repeating a Course

A course may be taken only once for grade. Since passing of all courses individually is a degree requirement, students must retake the course in which he will not secure pass marks; when offered and must successfully complete the course. A student will be allowed to retake maximum of two courses to achieve a minimum CGPA of 3.0. The grade earned on the retake examination will substitute the earlier grade earned by the student in that course. A student can retake a course only when it is offered by the college/university.

17. Credit Transfer and Withdrawal

A maximum of 25% of the total credit hours of course work completed by a student in an equivalent program of a recognized university/institution may be transferred/ waived for credit by the Dean on the recommendation of the campus chief/principal/head of the college/school. However, for such transfer of credit, a student must have received a grade of 'B' or better in the respective course. Courses taken more than two years earlier than the date of application will not be accepted for transfer of credit. Credit transfers will also be allowed from different programs of **MU**. In such cases, all credits earned by students in compatible courses with a minimum grade of B may be transferred to the new program.

The student may apply for withdrawal from the entire semester only on medical grounds. However, partial withdrawal from courses registered in a semester will not be entertained.

18. The discipline and rule for students

Students are strictly forbidden from adopting unfair means in class assignments, tests, report-writing, final examination and thesis work. The following would be considered as adoption of unfair means during examination:

- Communicating with fellow students for obtaining help.
- Copying form another student's script/report/paper.
- Copying from disk, mobile, palm of hand or other incriminating documents and equipment.
- Possession of any incriminating documents, whether used or not.
- Any approach in direct or indirect form to influence teacher concerning grade.
- Disobedient and unusual behavior which disrupts academic program.

If the instructor detects a student using unfair means, the student may be given an 'F' grade at the discretion of the Dean office/central Examination Board of **MU**. Adoption of unfair means may result in the dismissal of the student from the program and expulsion of the student from the college and as such from Mid- west University.

19. Dismissal from the Program

A student is normally expected to obtain a GPA of 3.0 in the semester-end examinations of the M. Sc. Str. program. If a student's performance falls short of maintaining this CGPA continuously over the semesters, he/she may be dismissed from the program.

20. M.Sc. Str. Engineering course stability

- The course is suitable for those students who has excellent skill in Mathematics, IT, structural analysis problem-solving ability; the ability to explain design plans, references and materials.
- The students should have excellent team working performance and knowledge of construction methods and materials, considering safe and economic criteria.
- The student should have ability of decision making, presenting high structural skill, and management performances

21. Thesis Research Criteria

With start of M.Sc. Program, **MU** will focus on the product oriented research work for students' thesis work. The main focus will be made on what Nepal needs for its infrastructure development and what the construction industries are facing problems in actual construction sites. With its consideration M. Sc. program may contribute the nation with the following 4 steps of research and development works.

21.1Basic Academic Research

This type of research work is basically to provide the depth knowledge to Master students. Analytical and practical knowledge from materials, as starting from its constituents' level to its hardened level, will be delivered with different types of experiments and analysis. Diversity on this research work (choose of many more parameters in each and every set of analytical and experimental work) may produce enormous data, the analysis of which may pave us for systemizing or developing different types of products. Continuation on such research and development work helps **MU** to produce more qualified engineers who may have capacity to compete domestically or internationally in their academic or professional career. Moreover, some brilliant research oriented candidates may be sent to overseas renowned universities, under student exchange program for their depth study (for short period), which may drastically upgrade the quality of their research work. Such programs will enhance the level of research and development work in **MU**.
Such research work falls within the thesis requirement of M.Sc. candidates.

21.2 Public Awareness Research Work

This correlates with abovementioned academic research. Main purpose of this program is to make public more conscious on engineering facilities / work what they are using / doing. Simply saying, a resident near **MU** should understand practically that how strong his building is as he has constructed it with his awareness on the design and quality control of different phases in construction work. Collaboration with Government agencies may lead to upgrade the quality control of public construction work. Coordination with various engineering related factories may help them to enhance the quality of their products or develop new ones. Collaboration with each sector results in Benefit-Benefit relation. Public will take benefit of quality and economy and **MU** may have enormous data from each sector for future analysis and development work. With continuation of such public oriented work for numbers of years, **MU** will be able to set up engineering data bank which will be core for further various qualitative researches and development works.

21.3 Construction/Industries Related Research (Filed and Industry Visits)

The succession of above two phases may enable MU to have collaboration with big construction or product-oriented industries. During the period of study, MSSE students will have frequent visits to construction sites and industries to elaborate the practical knowledge and sort out the problems they are facing. With such activities, MU may play the role of

technical consultant of every aspect of engineering works in various fields. Large scale of research work (i.e. real size experimental work and its analysis) can be carried out based on the requirement of different engineering industries. This stage directly benefits the country for its infrastructure development. Industries get benefit by enhancing conventional technologies/products or developing new ones; in turn, MU becomes the virtual National Research and Development Center.

21.4 Joint Research for Technology Transfer

It is the matured level of MU for its research and development activities. Each government/public/private sector be aware with the research capacity of PU, with which it is easy to explore its status overseas. MU may keep its capacity to collaborate with overseas renowned universities/business institutes for joint-research work, which is essential for Technology Transfer. It may enable Nepalese businessmen/industrialists to establish big scale factories to localize the internationally developed product. Moreover, it also helps conventional Nepalese businessmen to change their trend from importing readymade product to its core technology. It is vital important for overall development of Nepal itself.

22. **Detailed Curricular Structure**

The students those enrolled to M.Sc. Structural engineering program of MU must complete 15 courses, and Dissertation (equivalent to 12 credit hours).

The first semester is focused on developing the analytical procedure required for learning the core/functional area. The second semester is focused numerical and design part related to material and resistance of structure. The third semester is focused integrative courses of design with lab-oriented course. The Fourth semester is focused fully oriented to thesis. Students are required to attend classes in the college and take written examinations conducted by Dean Office, MU which will be held at the end of the first semester to third semester. In Fourth semester the students should present thesis report.

Curricular Structure and Course Details

S.N.	Course Code	Course Description	Credit
Year/Part: I/I			
1	STR511	Advance Structural Analysis	4
2	STR512	Structural Dynamics	4
3	STR513	Advanced Mechanics of Solids	3
4	STR514	Bridge Analysis and Design	4
5	STR515	Advance Geotechnical Engineering	4
Semester Credit Hours			**19**
Year/Part: I/II			
1	STR521	Finite Element Method	3
2	STR522	Seismic Resistant Design of Structures	4
3	STR523	Advanced Concrete Technology	4
4	ELE52*	Elective I	3
5	ELE52*	Elective II	3
Semester Credit Hours			**17**
Year/Part: II/I			
1	STR531	Advance Structural Design	4

2	STR532	Advance Structural Engineering Laboratory	4
3	ELE53*	Elective III	3
4	ELE53*	Elective IV	3
5	ELE53*	Elective V	3
Semester Credit Hours			**17**
Year/Part: II/II			
1	STR549	Dissertation Preparation	12
Total Credit Hours			**65**

Elective Courses

The following courses have been identified for electives. These courses offer students the flexibility to choose their needs and meet their career interests and goals in future. These are basically practical, sartorial and application courses which address the systematic integration across structure related disciplines. Hence, a wide range of elective options may be offered by a college/school. A college/school can also develop and offer such sector-focused elective courses with the prior approval of the Subject Committee and the Dean.

Elective I and Elective II (ELE52*)			
1	ELE521	Applied Seismology	3
2	ELE522	Rock Mechanics	3
3	ELE523	Theory of Plates and Shells	3
4	ELE524	Computer Aided Analysis and Design	3
5	ELE525	Seismic Hazard Analysis	3
6	ELE526	Disaster and Risk Management	3
7	ELE527	Design of Shell and Spatial Structures	3

Elective III, IV, and V (ELE53*)			
1	ELE531	Pre-Stressed Concrete	3
2	ELE532	Analysis and Design of Industrial structure	3
3	ELE533	Hydraulic Retaining Structures	3
4	ELE534	Analysis and Design of High-Rise Building	3
5	ELE535	Geotechnical Earthquake Engineering	3
6	ELE536	Design of Masonry Structures	3
7	ELE537	Repair and Retrofitting techniques of Structures	3
8	ELE538	Advanced Design of Steel Structures	3
9	ELE539	Non-Linear Analysis of Structures	3
10	ELE540	Optimization in Structural Design	3
11	ELE541	Seismic Assessments and Retrofitting of Structures	3
12	ELE542	Wind and Cyclone Effects on Structures	3
13	ELE543	Tunnel Engineering	3
14	ELE544	Prefabricated Structures	3

15	ELE545	Mechanics of Composite Materials	3

Thesis Work (Research Project)

In the third and fourth semester of their study period, participating students are required to undertake a research project and prepare an integrative research report in any concerned areas as approved by the college/school. Students are required to attend the viva-voce examination and give a seminar presentation of their report as organized by the college/school. Detailed evaluation scheme of the research project work is as below. For the evaluation of the research report, the college/school shall appoint internal and external examiners. The external examiner shall be appointed from the list approved by the Office of the Dean.

Semester I

STR511: Advance Structural Analysis (4 –0 – 0)

Course Objectives:
The main objective of this course is to provide advance and modified concepts of matrix analysis for the structural analysis of determinate and indeterminate structures. This course encourages students to perform structural analysis of advanced structures.

Course outcomes: At the end of the course,

- Students will be able to demonstrate a working knowledge of analysis of skeleton structures.
- Students will be able to demonstrate a working knowledge of execution of stiffness analysis code.
- Students will be able to understand limitations of direct stiffness/displacement method.

Course Contents:

1. Introduction (3 hrs.)
A Few Historical Remarks, Matrix Method of Analysis of Skeletal Structures, Methods of Analysis: Introduction to Finite Element method of Structural Analysis, Displacement Method: Stiffness Relationship. pin jointed trusses and grillage/grid/hybrid frames;

2. Influence coefficients (3 hrs.)
Physical significance, effects of settlements, temperature change and lack of fit, structure approach and member approach, stiffness method applied to large frames, local coordinates and global coordinates.

3. The Stiffness and flexibility Matrix Displacement Approach (10 hrs.)
Relation between flexibility and stiffness matrix, Stiffness Matrix of a Bar Element Subjected to Axial Force, Co-ordinate Transformations, Global and assembly of Stiffness Matrix, Application to Pin-Jointed Frames, Stiffness Matrix of a frameElement, Application of Matrix in Continuous Beams, settlements. Displacement relationships for axial force, couple, twisting moments – stiffness method

4. Matrix Analysis of Frames and 2D structure (10 hrs.)
Matrix Displacement Analysis of Planar Rigid-Jointed Frames, Neglect of Axial Strain in the Analysis of Planar Rigid-Jointed Frames, Inclined Supports,2D Various frames with different end conditions-plotting of bending moment diagrams

5. Boundary value problems (2 hrs.)
Approximate solution of boundary value problems, modified Galerkin method for one-dimensional boundary value, Ritz approach.

6. Stiffness Matrix Displacement, Plates and Shells of Revolution (10 hrs.)
Plate analysis, Co-ordinate Transformation, Element Stiffness Matrix & its Application, Conventional and numerical methods, Revolution of shell and stiffness matrix, Axisymmetric shell and plate problems. Closed boundary condition

7. Stiffness Matrix Displacement Analysis of Three-Dimensional Structures (12hrs.)
Co-ordinate system and Transformations, Application to Space Trusses & Space Frames., tetrahedron. Hexahedral element, 3D frames

8. Computer Applications & Use of Computer Packages (6hrs.)
Different Programming in computer using various software. Matlab, MathCad,SAP,StaadPro

9. Equation Solver |Technique (4 hrs.)
Solution of system of linear algebraic equations, direct inversion method-gauss elimination method-Cholesky method-banded equation solvers frontal solution techniques.

References:

1. Devdas Menon,"*Advanced Structural Analysis*", Narosa Publishing House, 2009.
2. Asslam Kassimali,"Matrix Analysis of Structures", Brooks/Cole Publishing Co., USA, 1999.
3. G.S. Pandit, S.P. Gupta, "*Matrix methods of Structural Analysis*", Tata McGraw Hill Co.
4. Martin, H.C. *Introduction to Matrix Methods of Structural Analysis* McGraw-Hill, 1966
5. Jain, A.K., *Advanced Structural Analysis with Computer Applications,* Nem Chand & Bros., Roorkee, 2nd ed
6. Cotes, R.C., Couties, M.G., and Kong, F.K., *Structural Analysis*, ELBS.
7. MC. Guire, W., and Gallagher, R.H*., Matrix Structural analysis*, John Wiley and sons.
8. John L. Meek., *Matrix Structural Analysis*, McGraw Hill Book company.
9. C.S. Reddy *Structural Analysis*.
10. Dawe *Finite Element Displacement analysis of Structures.* Clarendon Press, The Oxford University Press, New York, 1984.
11. Wang C.K., *Computer Methods in Advanced Structural Analysis* Intex Educational Publishers 1973
12. Gere. J.M. & Weaver, W., *Matrix Analysis of Framed Structures*3rd Edition, Van Nostrand Reinhold, CBS Publishers and distributors 1990

STR512: Structural Dynamics (4 – 0 – 0)

Course Objectives:
The objective of this course is to impart knowledge of the complex and modified engineering solutions for the dynamic problems in various structure due to effects of seismic force, wind and impact.
Course outcomes: At the end of the course,

- Students shall be able to understand the fundamental theory of structural dynamics and equation of motion in damping/non –damping cases.
- Students will be able to analyses and study dynamics response of single and multi-degree-of freedom systems acting with any type of loads.
- Use the available software for dynamic analysis of structure.

Course Contents:

1. Introduction (3 hrs.)
Sources of vibration, Problems related to Structural Dynamics, Degrees of freedom, Types of vibrations, Damping concepts in various structures Basics of linear Elasto-dynamics and Finite Element Methods in Structural Dynamics Nature of exciting forces, degrees of freedom and mathematical modeling of dynamic Systems An un-damped and damped free vibrations, Viscous and Coulomb's damping. Importance of vibration analysis, Nature of exciting forces, Mathematical modeling of dynamic system

2. Single Degree of Freedom System of structure (8hrs.)
Response to harmonic loading, Response to general dynamic loading using Duhamel's integral, Fourier analysis for periodic loading, State Space solution for response, Numerical solution to response using Newmark β method and Wilson θ method, Numerical solution for State Space response using direct integration. Simple Harmonic Motion, Equation of motion of discrete system, Modeling of Single Degree of Freedom (**SDOF**) structures, Free vibration response (damped and un-damped) of **SDOF** system, Forced vibration response of **SDOF** system to harmonic forces, Forced vibration response of **SDOF** system to periodic forces, Forced vibration response of **SDOF** system to impulsive forces, Forced vibration response of **SDOF** system to general dynamic forces, Time domain analysis, Frequency domain analysis for SDOF system.

3. Multi Degree of Freedom System of structure (10 hrs.)
Inverse iteration method for determination of natural frequencies and mode shapes, Dynamic response by modal superposition method. Direct Integration of equation of motion. Multiple Modeling of **MDOF** system structures, Equation of motion of **MDOF** system Concept of generalized coordinate, Lagrange's equations of motion, Vibration absorption and orthogonally properties, Free vibration response(un-damped and damped) of **MDOF** system, Natural frequencies and mode shapes, Normal coordinates and Normal Mode Theory, Forced vibration response of **MDOF** system, Practical methods to determine natural frequencies and mode shapes by Stodola's, Holzer's and Transfer matrix methods. Dynamic analysis of Rotating Structures

4: Multiple Degree of Freedom System (Distributed Mass and Load) (3 hrs.)
Single span beams, free and forced vibration, Generalized Single Degree of Freedom System

5. Dynamic Analysis for MDOF System of structure (6hrs.)

Frequency domain analysis for general dynamic forces and support motion for MDOF, Time dependent and domain analysis using numerical integration scheme for general dynamic loading for MDOF system applied with Seismic.

6. Discrete (meshing) System of Structures (6hrs.)

Partial differential equations of motion (for string, bar, beam), Axial vibration of a bar, Transverse vibration of a beam, Transverse vibration of a Euler beam, Torsional vibration of a bar, Approximate methods to determine natural frequencies and mode shapes in cases where orthogonal and non-orthogonal conditions.

7. Introduction to Nonlinear Dynamic Analysis (6hrs.)

Dynamic non-linearity in structures. Buckling of frame behavior, Elastic and inelastic behavior, Incremental equations of equilibrium; Step-by-step integration method for nonlinear dynamic case.

8. Special Topics in Structural Dynamics (3 hrs.)

Introduction to Dynamic effects of wind loading, moving loads, Vibrations caused by traffic, blasting and pile driving, Foundations for industrial machinery, Base Isolation.

References:

1. J. W. Smith: *Vibration of structures*. *Application in civil engineering design*: Chapman and Hall.
2. Hart and Wong. *Dynamics of structures-*
3. Clough R. W., Penzien J*, Dynamics of Structures*, McGraw Hill. international Edition1998
4. Chopra Anil, *Dynamics of Structures*, McGraw-Hill International Edition, 1998
5. Thomson W. T., *Theory of Vibration with Applications*, Prentice Hall, 5th Editon, 1997.
6. Paz, Mario, *Structural Dynamics Theory & Computation*, Von Nostrad Reinhold Company, Inc.
7. Humour, J.L., *Dynamics of Structures*, Second Edition, McGraw-Hill International Edition, 1989
8. A.K. Chopra: *Structural Dynamics and introduction to earthquake engineering*

STR513: Advanced Mechanics of Solids (3 – 0 – 0)

Course Objectives:
The objective of this course is to make the students capable of analyzing properties material and structure leading to theoretical approach of advance structural behavior of material and resistance of structure.
Course outcomes: At the end of the course,

- Students shall be able to understand the basic concepts of theory of elasticity.
- Students will be able to solve problems of elasticity and plasticity.
- Students will be able to apply numerical methods to solve continuum/closed problems

Course Contents:

1. Analysis of Stresses and strains of structures (4hrs.)
Definition of stress and strain at a point, Stress Components on an arbitrary Plane; Stress tensor matrix and use in analysis of structure; various Stress components on a rectangular element in Cartesian coordinate system; Derivation of stress equilibrium equations, transformation of stresses, stress invariants; Displacement relations, strain compatibility condition and stress compatibility conditions. Tensor Matrix

2. The Stress Field (3 hrs.)
Differential Equations of Equilibrium in stress field, Hydrostatic and Deviatoric Components

3. The Strain Field (3 hrs.)
Elementary Concept of Strain, Stain at a point, Principal Strains and Principal Axes, Compatibility Conditions Aerodynamic strains

4. Relationship of stress strain (6 hrs.)
Constitutive Relations, Cartesian Tensors and Equations of Elasticity, Linear Theory of Elasticity, Generalized Hook's law for Isotropic, Orthotropic, antistrophic. Transversely Isotropic materials; Plane stress, strain; introduction to Axisymmetric problems, Problems in 2D, 3D Cartesian coordinate system, bending of frames; Principle of virtual work and its application in 2D, 3D cases. Airy's stress function. Two-Dimensional Problem in Polar Coordinates: General equations of equilibrium, Stress function and equation of compatibility with zero body forces. Analysis of thick cylindrical shells with symmetrical leading about the axis, Pure bending of curves bars, Strain components in polar coordinates, Rotating disks.

5. Transformation of coordinates (6 hrs.)
Transformation, relationship and application of Cartesian and Polar coordinate system; equations of equilibrium, Partial differential equations and integral Equations; Strain displacement relations, Stress-strain relationship; Fourier series formulation integral; Functional Approximation Strain-displacement relationship for plane stress and plane strain conditions and tensor matrix; Stress concentration problems. Air- space structural problems.

6. Axisymmetric and structures (5 hrs.)
Static Equilibrium equations; Strain displacement relations; Stress-strain relationship; compatibility equations; Plane stress and Plane strain conditions in axisymmetric problem; Cylinders and shell structure subjected to internal and external pressure. Plate membrane and bending theory

7. Torsion of various structures (8 hrs.)

Torsion related equation for general prismatic structure; Warping of rectangular sections; St. Venant's theory; Prandtle's stress functional and approach; Torsion of Circular, Elliptic cross section, Torsion of Thin Tubes, Membrane analogy torsion of bar of narrow rectangular cross section. Torsion of thin-walled structures by membrane and bending analogy; Torsion of rolled sections; shear flow analogy in different section of structure with different thickness.

8. Analysis of curved beam in plan/elevation (3hrs.)

Analysis of Beams Curved in Plan such as cantilever circular arc, Semicircular beams fixed at two ends and subjected to central concentrated load, simply supported semicircular beam subjected to UDL, UVL supported on three equally spaced columns, Analysis of circular ring beam. Analysis of Beams Curved in Elevation, Application to curved circular and elliptical Rings and Crane hooks.

9. Analysis of Beams on Elastic Foundation (4 hrs.)

Differential equation related to spring analogy, Elastic theory of beam; Infinite beams with concentrated load, Theory of Elasticity and formulation. Concentrated point load, moment, and uniformly distributed load; Semi-Infinite beams with free end subjected to uniformly distributed load, hinged/fixed end; Finite beams with different end. Condition

10. Plastic deformation in structures. (3 hrs.)

Strain-Hardening, Idealized stress-strain curve, Yield Criteria, von Mises Yield Criterion, Tresca Yield Criterion, Plastic Stress-Strain Relations, Principle of Normality and Plastic Potential, Isotropic Hardening Graphical representation of criterion of yielding; Yield surface; flow rule in different section (plastic stress and strain relationship). Elasto-plastic problems of beams and in frames in bending; plastic torsion in rectangular section.

References:

1. A.R. Ragab, S.E. Bayoumi**,** *Engineering Solid Mechanics*, CRC Press,1999
2. L.S. Srinath *Advanced Mechanics of Solids*, Tata McGraw Hill,20
3. Timoshenko and Goodier- *Theory of Elasticity*, McGraw-Hill Publications
4. S. Crandall, N. Dahl and T. Lardner - *Mechanics of Solids*, McGraw Hill Publications
5. Wang - *Applied Elasticity*, Dover Publications
6. Irving Shames, *Mechanics of deformable solids*, Prentice Hall
7. Sadhu Singh. *Theory of Elasticity* Khanna Publishers, 1979 - 658

STR514: Bridge Analysis and Design (4-0-0)

Course Objectives:
The main objective of this course is to make able to design RCC and steel bridge and construction supervisory. This course will give deep knowledge for bridge structure design.
Course outcomes: At the end of the course,

- Students shall be able to understand the basic concepts of analysis of bridge.
- Students will be able to solve simple problems substructures.
- Students will be able to apply lateral and movable loads in any types of bridge.

Course Contents:

1. Introduction to bridge engineering (4 hrs.)
Introduction to bridge engineering and components of bridge. Historical background of bridges and types. Bridge aesthetics and proportioning. Design process. Review of applicable design codes. Loads on bridges and force distribution. Bridge geometry. Introduction and selection of type of Bridges and their axis; Layout of bridge axes; Introductory part of using IS code IRC and other codes loading on bridge, Data required for design if bridge.

2. Bridge type selection and Analysis (7hrs.)
Combination of gravity load and seismic performance in bridge; Theories of Lateral Load distribution on bridge; Grillage Analogy; Seismic Analysis for bridge; Introductorily part of geo- tech and soil treatment, hydrological analysis

3. Design of Steel bridge. (10 hrs.)
Vehicle, Railway loadings, dynamic effect consideration, Vehicle, Railway culvert bridge with steel beams, Plate girder bridges, Box girder bridges, Steel Truss bridges, Vertical and Horizontal stiffeners.

4. RC Bridge Design with Long/short Span (15hrs.)
Design of RC Bridge; continuous girder bridges, balanced cantilever bridges, Design of Composite Bridges (Steel and Concrete Design of RC Box girder bridges Introductory part of geo tech and soil treatment in design of bridges; Arched Bridge design. Balanced cantilever bridges, Analysis and design of Slab Bridge, Skew slab bridge.
T- girder Bridge. Flyover bridge analysis and design

4. Prestressed and post tension concrete bridges (12 hrs.)
Flexural and torsional parameters – Courbon's theory – Distribution co-efficient by exact analysis – Design of girder section – maximum and minimum prestressing forces – Eccentricity – Live load and dead load shear forces – Cable Zone in girder – check for stresses at various sections – check for diagonal tension – Diaphragms – End block – short term and long-term deflections post tension concrete bridges design.

5. Bearing and Substructure design (6 hrs.)
Design of Bearings, Plates in bridge, Design of abutments, piers and their foundations; Types of bridge foundations, Design of foundations; Open well, Sinking well foundation, pile foundation

6. Repairing and retrofitting of bridge (6 hrs.)

Earthquake Damages of Bridges, Structural Deficiencies, Retrofit Philosophy and steps, Jacketing; steel, concrete and composite jacketing, smart material, Maintenance of bridges, Research and development Issues: Recent Advances in Retrofitting Techniques

References:

1. D. Jhonson Victor "*Essentials of Bridge Engineering*", Oxford University Press.
2. N. Krishna Raju, "*Design of Bridges*", Oxford & IBH Publishing Co.Pvt.Ltd, New Delhi
3. Jagadeesh, T.R. and Jayaram, M.A., "*Design of Bridge Structures*", Prentice Hall of India Pvt. Ltd. 2004.
4. . Ponnuswamy, S., "*Bridge Engineering*", Tata McGraw Hill, 2008.
5. Raina V.K." *Concrete Bridge Practice*" Tata McGraw Hill Publishing Company, New Delhi, 1991.
6. Rajagopalan N., *Bridge Super Structur*e, Narosa Publishing House Pvt. Ltd., First Edition, 2006.
7. Derrick Beckett, *An Introduction to Structural Design of Concrete Bridges*, Surry University

8. Taylor, F.N, Thomson .S.E & Smulshi.E*, Reinforced concrete Bridges*, John Wiley 1999
9. Balcht.B & Jaegar.L.G, *Bridge Analysis Simplified*, McGraw Hill, 1985

STR515: Advanced Geotechnical Engineering (4 – 0 – 0)

Course Objectives:
The course gives a basic understanding of the nature of soil, analysis of structures subjected to earthquakes and design of structures to resist in various type of soil strata below ground level for proper foundation type selection.
Course outcomes: At the end of the course,

- Students will understand the concepts of geo technical part in structural design
- Students will be able to solve problems related to soil treatment in foundation.
- Students will be able to apply and analyze seismic (lateral)load in foundation.

Course Contents:

1. Introduction (10 hrs.)
Principles of Geo-technical Engineering, soil exploration and Design of Foundations, Types of shear failures in foundation soils, Types of foundations, Design Loads, Basic Concepts of safe and allowable bearing capacity. Shallow Foundations General requirements for the design of foundations, Soil interaction theories for analysis of foundation, Different types of foundations; Types and suitability of shallow foundations, Review of: general principles, settlement and Lateral Pressure, factors affecting location and depth of foundation,Boring, certain tests, sampling, testing

2. Analysis of foundation (15 hrs.)
Bearing capacity and settlement analysis, Bearing Capacity theories: Tezaghi, Meyerhof, Brinch Hansen: foundations subjected to eccentric and inclined loads; foundations on slopes; Types of mat foundations; Analysis of mat foundations by conventional method, elastic line method and finite difference method, Earthquake effect consideration in analysis of foundation. Uniform and Differential Settlements, Elastic and Consolidation Settlements, Settlement analysis in cohesion less soils by Schemartmann and Hartman method, Penetration tests; Permissible settlements as per IS 1904-1978, causes of settlement, settlement Control. Analysis of open well, sinking well foundation. Soil treatment analysis

3. Design of foundation (20 hrs.)
Design of shallow foundation: spread footing, Strap footing, combined footings, mat foundation, Deep foundations: Types and methods of designing pile foundations; bearing capacity and settlement analysis and design of piles and pile groups, laterally loaded piles, pile groups subjected to inclined loads, Pile testing, load capacity- dynamic formulae, static formula; pile load tests- Vertical load test, lateral load test, Cyclic load test;, negative skin friction on single pile and pile groups; laterally loaded piles - Broom's Analysis, IS Code method; Under reamed piles – Load capacity, design and construction. Design of bridge-sub-structures, Design of sheet pile walls, Design of Retaining wall, Soil Dynamics and Design of machine Foundation, Design of coffer dams and diaphragm walls, Design of open well , sinking well foundation ,Soil treatment design

5. Special design and Construction of foundation (15 hrs.)
Foundations in Expansive Solis: Introduction, Identification of expansive soils, Swell potential and swelling pressure, Active depth, Foundation Problems, Foundation practices in expansive soils, Soil Replacement and 'CNS' concepts. Foundations of Transmission Line Towers: Introduction, Necessary information, Forces on tower foundations, General design criteria, Choice and type of foundation, Design procedure and construction of pile foundations, Combined design of pile and mat foundations, Types and components of well

foundations, methods for the design of well foundations, Problem during well sinking and their solutions

References:

1. Selvadurai, APS, *Elastic analysis of soil foundation interaction* Elsevier Scientific Pub. Co., 1979 - Technology & Engineering
2. Poulos, HS & Davis EH ,*Pile foundation analysis and design* 1980 Wiley
3. Scot, R.F *Foundation Analysis*. Prentice-Hall, Jan 1, 1981 - Technology & Engineering
4. State of Art Report ,*Structure Soil interaction*, Institution of Structural Engineers,1978
5. Kramer, S.L *Geotechnical Earthquake Engineering* Prentice Hall PTR, 1996 - Technology & Engineering
6. Murthy, V.N.S., *Geotechnical Earthquake Engineering* CRC Press.

Semester II

STR521: Finite Element Method (3– 0 – 0)

Course Objectives:
The objective of this course is to make the students able for analysis of various structures in discrete form and negotiate and support with base knowledge for further developed Computer Aided Design programming.

Course outcomes: At the end of the course,

- Students will be able to understand the analysis procedure of finite element method
- Students will be able demonstrate a working knowledge of execution of finite element code with programming.
- Students will be able solve continuum, discrete problems using finite element analysis.

Course Contents:

1. Introduction and application of Finite Element Analysis (5 hrs.)
History and applications of FEM. Spring and bar elements, introduction to Minimum Potential Energy Principle Direct Stiffness Method: Nodal Equilibrium equations, Assembly of global stiffness matrix, Element strain and stress Beam Elements: Flexure element, element stiffness matrix, element load vector. Computational methods and Mechanics and FEM; Statics and Dynamics Analysis; Linear and Non-linear Analysis; 3D Discretization Methods; Introduction of finite element; Archimedes FEM; The Physical FEM – Computational steps; History of Development & Application of FEM; Advantages and Disadvantages of FEM; SDM and FEM with Numerical Examples and Exercises. Finite Difference Methods and application.

2. Mesh generation and software application in FEM (3 hrs.)
Preprocessing - Mesh generation – region and block representation, generation of node numbers, mesh plotting- Post Processing – Types of data available – displaying results graphically – listing nodal and element solution data. Convergence: Requirements for convergence – p and h Methods of Mesh Refinement –Discretization Errors – Auto and Adaptive Mesh Generation Techniques - Error Evaluation.

3. Finite element analysis of one dimensional problems (3 hrs.)
One dimensional problems - Coordinate systems – global, local and natural coordinate systems, shape functions – Bar, beam and truss element - Generation of Stiffness Matrix and Load Vector.

4. System of Linear Equations and storage system (2 hrs.)
Skyline approach; Frontal Solver Technique; Sub structuring Technique and problems; Symmetric and skew symmetric structures, storage and banded matrix

5. Application to Solid Mechanics planer Stress (4 hrs.)
Three nodded Triangular Element CST; Displacement Field function; Strains in terms of Displacements; Constitutive Law of elastic constant; Nodal Forces using Equilibrium equations; Assembly process of Element Stiffness; Boundary Condition and types ;Solution for Nodal displacements; Numerical Problems. Use of software to compare analytical results. Isoparametric formulation of the plane Quadrilateral Element, Axi-symmetric stress analysis, Strain and Stress computations.

6. Method of Weighted Residuals and PMPE (5 hrs.)

Galerkin finite Element Method, Application to structural elements Interpolation functions, Compatibility and completeness requirements, polynomial forms. Applications Total Energy and their Complimentary in strictures; Principle of Virtual Work; Principle of Stationary and Potential Energy; Principle of minimum Potential energy– Stability of Equilibrium ;Variation-differential analysis related to Finite difference –Ritz Approach, Rayleigh quotient,Galerkin's approach

7. Higher Order 2D Elements (8 hrs.)

Linear Strain Triangle (LST stiffness using natural coordinates); Quadratic Strain Triangle and condensed stiffness; Quadratic Strain Triangle type I and II Tabulation of CST, LST and QST computations; Rate of convergence; Numerical Examples and Exercises Serendipity Family; Linear Serendipity Rectangle; Higher order Serendipity Elements; Lagrangian Family; Second order Lagrangian Element; Hermitian Family ,Quadrilateral element from CST elements – example; Examples (shape function and nodal load vector);Numerical and Exercises Shape function and isoparametric mapping; Uniqueness of mapping; Sub-Iso-Super Parametric Elements; Isoparametric methods; Isoparametric quadrilateral; Gaussian Quadrature; Numerical Examples ; Hexahedron Element Family; Order of Quadrature; Incompatible Elements

8. Three-dimensional elements – Axisymmetric Stress Analysis (4 hrs.)

Introduction; Axisymmetric Elements; Axisymmetric Solid Elements; Three-dimensional elements – Tetrahedral Family; Rectangular Hexahedral Elements

9. Finite Element Analysis of Plates & Shells (3 hrs.)

Basic Theory of Plate Bending; Displacement Functions and their application in shell, plate; Theory of Shells; Plate Elements; Shell Elements, mode shapes, shape functions of shell plate.

10. Stability and Dynamic Analysis (4 hrs.)

Introduction; Linear Stability Analysis; Stability problem and Beam Column Problems; P-Δ relation, Dynamic Analysis; Pin jointed Truss Element; bar element, Frame Element; Master and Slaves nodes in FEM, consistent mass modeling. Mass stiffness matrix

11. Nonlinear Stress Analysis (4 hrs.)

Introduction; Solution Algorithm and Convergence Criteria; Stress Stiffening; Geometric Nonlinearity; Material Nonlinearity; Problems of Gap and Contact in structure ; Modeling and Convergence; Applications of non-linearity in FEM .

References:

1. RjasekaranS., M. Mukhopadhyay *Computer and Structural Analysis*, 1993, Oxford IBH publishing company.
2. Cook R.D., *Finite Element Modeling for Stress Analysis*, John Wiley and Sons, 1995.
3. Klaus Jurgen Bathe, *Finite Element Procedures*, Prentice Hall second edition, ISBN 8120310756.
4. ZienkiewiczO.C. and R. L. Taylor*, The Finite Element Method*, New York McGraw Hill, 1991.
5. Reddy J. N. 1993, *An Introduction to Finite Element Method*, Mc-Graw Hill, New York, second edition.

STR522: Seismic Resistant Design of Structures (4 – 0 – 0)

Course Objectives:
The course gives a basic understanding of the nature of seismic waves and earthquakes, analysis of structures subjected to seismic force and design of structures to resist strong ground motions and response spectra performing soil treatment and super structural treatment.

Course outcomes: At the end of the course,

- Students will be able to analyze the structures ant thier components by understanding their behaviour during earthquake
- Students will be able to design and prepare details for execution citing relevant IS and other codes.
- Students will be able to apply numerical methods to solve seismic resistant analysis.

Course Contents:

1. Introduction of Seismic Resistant Design (4 hrs.)
Characteristics of earthquake, Seismic response of structures, Concept of earthquake resistant design. Codal provision for design of buildings in vulnerable seismic zones, introduction to design of liquid storage tanks, liquefaction, non-engineered construction, Effects of Seismicity; Theories and application of seismic resistant Design; Basic requirements for Seismic Resistant Structures. Base shear criteria in seismic analysis.

2. Seismology and Causes of Earthquake (8 hrs.)
Earthquakes and Seismic hazard; Causes of Earthquakes; Mechanism of Earthquakes; Measures of Earthquakes; Attenuation Laws; Temporal and Spatial Models of Earthquakes; Response Spectrums of Earthquakes; Seismic Zoning; Seismic Hazard Analysis Earthquakes, Epicenter, Hypocenter and earthquake waves, Measurement of ground motion, Seismic regions, Intensity and Isoseismals of an earthquake, Magnitude and energy of an earthquake, Consequences of earthquakes, Seismic zoning. Earthquake Response of Linear Systems: Earthquake excitation, Equation of motion.

3. Probability criteria in Seismic Resistant structure (6 hrs.)
Random and scattered Variables; Distribution Functions; Multi-dimensional and MDOF Random Variables; Conditional Probability; Statistical Independence; Central Limit Theorem; Liapanov's and Linderberg Feller's Theorems, Probability and seismic consideration to seismic design of structure , Time history, Response spectra.

4. Response Spectra of Structures (6 hrs.)
Review of Single Degree of Freedom System to Support lateral Movement.; Mode Shapes and Frequencies of Multi Degrees of Freedom System; Normal Mode Theory and analysis ; Mode Participation Factors; Pseudo Static Force in Each Mode of Vibration due to Earthquake. Response quantities, Response history, Response spectrum concept, Deformation, Pseudo-velocity, and Pseudo-acceleration, Response spectra, Peak structural response from the response spectrum, Response spectrum characteristics, Elastic design spectrum, Comparison of design and response spectra, Distinction between design and response spectra.

5. Structure resisting seismic Forces. (8 hrs.)
Different Structural Systems for Seismic loads; Floor Diaphragms and constraints; central, cantilever rigidity consideration Seismic Load distribution with Rigid Floor

Diaphragms; Moment Resisting Frames; Seismic Load Distribution in Framed Buildings ; Shear Walls; Shear Wall with Openings; Frame – Shear and masonry Wall System

6. Response Spectra (4 hrs.)

Theory and development, Tripartite response spectra, Response Spectrum Analysis for MDOF System; Time History Analysis of MDOF System for Single and Multi-point excitations, response spectra and application for soil treatment

7. Seismic-Hydro- Dynamic Effects. (4 hrs.)

Seismic resistant design of Dam, submerged building; Vibration and seismic design consideration for Liquids intze Tanks, underground water tanks; Vibrations of Submerged Structures like Piers and abutments, Floating bridges. Hydrodynamic pressures in tanks.

8. Seismic Resistant Design and considerations (10 hrs.)

Seismic Design concepts, structural response, principles of frame design, R.C. Ductile frames, shear walls, Masonry structures ,composite structures, drift and lateral stability criteria, Seismic Resistant Design of tall and vulnerable buildings. Choice of earthquake resisting systems for low rise, medium and high rise buildings. Behaviour of RCC members under cyclic loading. NBC, IS and other international code Provision for Various Structures Seismic Design of Multistorey buildings: By seismic coefficient method and Response spectrum method, Base shear, Fundamental period of buildings, Distribution of forces along the height Seismic design of elevated towers: Introduction, Behaviour under seismic loads, Design features, Water tower as a rigid jointed space frame, Seismic design of Stack like structures: Introduction, Fundamental period of vibration, Dynamic bending moment, Shear diagram

9. Seismic resistant design with consideration of ductility (6 hrs.)

Ductility of various structural materials, Plastic Design and plasticity of Structures for Seismic Resistant; Design Based on Energy Criterion; Ductility Factor Method; Codal Provisions.

10. Vibration control techniques (4 hrs.)

Active and Passive Control, Various Technique of active and Passive Control, Base Isolation Concept, Dampers for seismic response mitigation, Retrofitting Technique for buildings, bridges and other structure.

References:

1. Bruce A. Bolt, *Earthquakes*, W. H. Freeman and Company, New York
2. Farzad Naeim , *The Seismic design handbook* , Kluwer Academic Publishers Group, The Netherlands
3. T. Paulay and M.J.N Priestley , *Seismic Design for R.C. and Masonry Building* , John Wiley and Sons
4. IS 1893,IS 13920,IS 4326
5. James Kelly. *Seismic isolation*: From theory to practice:
6. An introduction to seismic isolation:
7. Newmark, N. M., and Rosenblueth, E., *Fundamentals of Earthquake Engineering*, Prentice-Hall, Inc .Englewood Cliffs, N. J., 1971.
8. S.L. KRAMER, (1996*),"Geotechnical Earthquake Engineering",* Prentice Hall, Upper Saddle River, NJ
9. David Dowrick, *Earthquake Resistant Design And Risk Reduction*, 2009, John Wiley & Sons, Ltd.

STR523: Advanced Concrete Technology (4 – 0 – 2)

Course Objectives:
Main objective of this course is to provide the advanced knowledge on concrete technology in aspect of quality control on materials, mixing and construction procedure so that they will have depth knowledge on how to secure the strength, serviceability and durability of advanced concrete structures.
Course outcomes: At the end of the course,

- Students will be able to know about advance technology in concrete grades.
- Students will be able to explain characteristics of concrete in resistance.
- Students will be able to modify concrete technology during thesis work.

Course Contents:

1. Introduction (4 hrs.)
Review on ingredients, mix design, fresh properties, hardened properties and durability of ordinary concrete.

2. Theoretical and Practical Aspects of Mix Design (5 hrs.)
Role of ingredients in concrete, Theoretical philosophies of mix design, Mix design by empirical method, Practical aspect of mix design, Mix design change methodologies and criteria.

3. Mixing (8 hrs.)
Review of methods and philosophies of IS, BS and ACI methods, mix design for special purposes. Acceptance criteria for compressive strength of concrete Dispersion and coating mechanism of particles, Mechanism of mixing, Types and efficiencies of mixers, Role of water particle and inter-particle forces, Quality control on Ready Mixed Concrete (RMC) plant.

4. Special and Fresh Concrete (12 hrs.)
Lightweight concrete, autoclaved aerated concrete, no-fines concrete, lightweight aggregate concrete and foamed concrete, High strength concrete, refractory concrete, high density and radiation-shielding concrete, polymer concrete, fiber-reinforced concrete, mortars, renders, recycled concrete, Ferro Cement, Self-Compacting Concrete. Rheology and workability of freshly mixed concrete, Importance of air content, Theoretical aspect of bleeding rate, Required quality control during production of fresh concrete. Special processes and technology for particular types of structure: Sprayed concrete, underwater concrete, grouts, grouting and grouted concrete, mass concrete, slip form construction, pumped concrete, concrete for liquid retaining structures, vacuum process, concrete coatings and surface treatments

5. Construction Procedure and Quality and test Control (10 hrs.)
Damp proofing, Different types of transportation methods of concrete to site, Placing and compaction methods, Importance and types of curing, Inspection and maintenance criteria of concrete structures, Safety management, Adoption of Total Quality Management (TQM) in construction. Analysis of fresh concrete, Accelerated testing methods, Tests on hardened concrete, Core cutting and testing, partially destructive testing, Non-destructive testing of concrete structures

6. Different Types of Concrete in Different Structures (8 hrs.)
Dam concrete, Roller Compacted Dam (RCD) concrete, Self-Compacting Concrete (SCC), High Strength Concrete, Marine Concrete, Fiber Concrete, High Ductile Mortar (HDM),

Recycled concrete, Lean concrete, Light weight concrete, Concept for development of new types of concrete.

7. Strength, Serviceability and Durability of Concrete (8 hrs.)

Development mechanism of strength in concrete, Creep and shrinkage, Effect of honeycomb and large voids in structures, Cracks, vibration and impact, Selection of materials for high strength and durable concrete, Physical and chemical affecting factors for durability.

8. Enhancement on Research and Development for New Types of Concrete (5 hrs.)

Recently developed new technologies in concrete, On-going research and development works in concrete, Review of international journal papers with analysis and judgment capacity

Experiments and Tests:

1. Development of different types of concrete (ordinary, dam, high strength and self-compacting concrete etc.)
2. Development of light weight concrete
3. Development of different fiber concretes
4. Nondestructive tests

References:

1. Treval C. Powers, *The properties of Fresh Concrete.* .John Wiley & Sons, Inc.1968
2. A. M. Neville, *Properties ofConcrete.* 5th Edition.
3. A. M. Neville, J. J. Brooks, *Concrete Technology*, Second Edition
4. Tek Raj Gyawali, *Concrete Manual for ME Students*

STR531: Advanced Structural Design (4 – 0 – 0)

Course Objectives:
The main objective of this course is to provide basic concepts for the design of various reinforced concrete elements with codal provisions. This course would lead to students to gain knowledge of advance design of reinforced concrete structure.
Course outcomes: At the end of the course,

- Students will be able to know about complex and advance Structural design.
- Students will be able to know modification in design of RC and prestressed concrete.

Course Contents:

1. Introduction (8 hrs.)
Review of limit state Design for shear flexure torsion and combined stresses of beams, slabs &slender columns according to NBC IS 456-2000. Safety and serviceability, Calculation of deflection & Crack width according to NBCIS 456-2000Factors affecting Crack width in beams, Mechanism of Flexural cracking Calculation of crack widths, Simple Empirical method , Estimation of Crack width in beams by IS 456 of BS 8110 , Shrinkage and Thermal Cracking

2. Deflection criteria Design of special RC elements (20 hrs.)
Introduction -Short-term Deflection of beams and Slabs -Deflection due to –Imposed loads - Short- term deflection of beams due to applied loads- Calculation of deflection by IS 456 - Calculation of deflection by BS 8110 - Deflection calculation by Eurocode –IS -ACI Simplified Method - Deflection of continues beams by IS 456 - Deflection of Cantilevers - Deflection of Slabs, Design of slender columns, Grid floors, curved, inclined beams, Deep beams, plain and reinforced concrete walls, Corbels & Edge (Spandrel) Beams, Reservoir, shear wall.

3. Design of Slabs (12 hrs.)
Introduction - Checking for One-way (wide beam) shear - Two-way (Punching) shear Permissible punching shear - Shear due to Unbalanced Moment (Torsional moments) Calculation of j values - Strengthening of column areas for moment transfer by torsion which produces shear, Shear Reinforcement Design, Effect of openings in Flat slabs Recent Revisions in IS code, Shear in Two way Slabs with beams Design of circular an flat slabs, Yield line analysis of slabs

4. Design of Folded plates: (8 hrs.)
General features and types, Structural behavior, analysis and design of sectorial plates, design using program FORTRAN and CAD. Connectivity analysis and design of folded plates. Fixed and hinged tye connection. Edge zone features of folded plates.

5. Design of Shear wall (8 hrs.)
Introduction, Classification of shear walls, Classification according to behavior, Loads in shear walls, Design of Rectangular and flanged shear walls, Derivation of formula for moment of Resistance of Rectangular shear walls

6. Prestressed and post tension concrete structure Design (4 hrs.)
Design of statically determinate and indeterminate prestressed and post tension concrete structure.
References:

1. P.Purushothaman, *Reinforced concrete Structural Elements*: *Behaviour, analysis and Design*, TATA McGraw Hill
2. P.Dayaratnam *Limit State Design of Reinforced Concrete Structures*, Oxford & IBH Publishers
3. Krishna Raju N. *Advanced Reinforced Concreted Design*, (CBS Publishers& Distributors)
4. Varghese P C, *Advanced Reinforced Concrete Design*, (Prentice Hall of India)
5. BhavikattiS. S, *Advanced RCC design Volume II*, New Age International, 2008
6. Ramamurthum, S. *Reinforced concrete design of structures*

STR532: Advanced Structural Engineering Laboratory (0 – 0 – 6)

Course Objectives:
This course provides knowledge of the experimental tests to assure and compare database results of strength, stiffness and stability of structures under possible different actions in any type of loading, material and support conditions.

Course outcomes: At the end of the course,

- Students will be able to know about practical Laboratory work and tally the analytical data.
- Students will be able to know about stability and durability during test of various structures.
- On completion of this laboratory course students will be able to cast and test RC beams for strength and deformation behaviour.
- Students will be able to test dynamic testing on steel beams, static cyclic load testing of RC frames and non-destruction testing on concrete
- Students shall collect laboratory data for their thesis work.

Course Contents:

1. Concrete Laboratory
Concrete tests: Properties, Tests for fresh light weight and hardened Concrete in successive duration., destructive and non-destructive testing, slump test, shear and compressive test.

2. Reinforced Concrete Laboratory
Testing of Reinforced Framed structures, Testing of curved beam and RC Slab of various shapes

3. Pre-cast post tension Concrete Laboratory
Testing of precast post tension concrete beams and slabs, triangular rectangular slab testing

4. Steel timber aluminum test Laboratory
Testing for reinforcing bars, steel section, Timber and Aluminum sections, Model Tests on still base plates

5. Dynamic mass testing of structure
Dynamic test on SDOF, MDOF system; Determination of Mode Shape Frequencies of simple beam and frames and comparing results with analytical approach

6. Stress-strain analysis Laboratory
Stress- strain gauge test. Two- and three-dimensional photo elasticity, velocity-pulse test

Notes: The course shall be outlined with a target of about 7 experiments.

List of experiments
1. Fabrication, casting and testing of simply supported reinforced concrete beam for strength and deflection behaviour.
2. Testing of simply supported steel beam for strength and deflection behaviour.
3. Fabrication, casting and testing of reinforced concrete column subjected to concentric and eccentric loading.
4. Dynamic testing of cantilever steel beam
a. To determine the damping coefficients from free vibrations.
b. To evaluate the mode shapes.

5. Static cyclic testing of single bay two storied steel frames and evaluate
a. Drift of the frame.
b. Stiffness of the frame.
c. Energy dissipation capacity of the frame.
6. Determination of in-situ strength and quality of concrete using
i) Rebound hammer and
ii) Ultrasonic Pulse Velocity Tester.

7. Effect of admixtures in concrete for workability, strength and durability

Laboratory Rquipment Requirements
1. Strong Floor
2. Loading Frame
3. Hydraulic Jack
4. Load Cell
5. Proving Ring
6. Demec Gauge
7. Electrical Strain Gauge with indicator
8. Rebound Hammer
9. Ultrasonic Pulse Velocity Tester
10. Dial Gauges
11. Clinometer
12. Vibration Exciter
13. Vibration Meter
14. FFT Analyser

References:

1. Dally J W, and Riley W F, "*Experimental Stress Analysis*", McGraw-Hill Inc. New York, 1991
2. Lang, K. Herwig, A. *Confinement of reinforced concrete columns* 2014, 16, 271-292, CRC Press, Boca Raton
3. Czaderski, C *Flexural and Shear Strengthening of Reinforced Concrete Structures* The International Handbook of FRP Composites in Civil Engineering Part III Externally Bonded FRP Composite Systems for Rehabilitation

Elective I and Elective II (ELE52*)

ELE521: Applied Seismology (3 – 2 – 3)

Course Objectives:
Seismology is the study of the waves generated by earthquakes and transmitted through the Earth. Locating where earthquakes occur is one of the most basic applications of seismology, and that information is crucial in identifying and characterizing faults and regional fault zones.

Course Contents:

1. Introduction (1 hr.)
Definition, Regional Seismic Activity

2. Seismic Source Characterization (2 hrs.)
Seismic Sources, Area Sources, Multiple Area Sources, Background Sources, Fault Sources, Mapping of Area and Fault Sources

3. Seismo-tectonics of Faults (3 hrs.)
Definition of Fault, Active Fault, Normal Fault, Reverse Fault, Dip-Slip Faults, Strike-Slip Faults, Transform Faults, Distances from the fault plane, Horizontal Distance, Rupture Distance, Seismogenic Distance, Area (Length) of Rupture, Fault Displacement

4. Earthquake Characterization (3 hrs.)
Definition of Earthquake, Plutonic earthquakes, Inter-plate and Intraplate Earthquakes, Cluster Earthquakes, Swarm earthquakes, Micro earthquake, Focus or Hypocenter, Epicenter, Depth of an Earthquake

5. Earthquake Waves (3 hrs.)
P-Waves, S Waves, Love Waves (Surface Waves), Rayleigh Waves, S-P interval, Typical Frequencies of Vibration, Engineering Implications of Surface Waves

6. Earthquake Instrumentation (3 hrs.)
Seismoscope, Seismograph, Seismometer, Seismic Coefficient, Accelerographs, Broadband seismographs, Constants of Seismometers, Foreshocks and Aftershocks

7. Bedrock Characterization (3 hrs.)
Seismic Bedrock and Engineering Bedrock, Ground Motion on Bedrock from rupture pattern of fault, Ground Motion on Bedrock from Attenuation Relationships, Topography effect on Ground Motion, Earthquake Source identification and geometry

8.Earthquake Magnitude, Duration, Recurrence (5 hrs.)
Earthquake Magnitude, Scale to Measure the Strength of an Earthquake, Different Magnitude Scales, Determination of Richter Magnitude, Earthquake Size using Moment Magnitude scale, Saturation of Earthquake Magnitude, Quantification of Earthquake Magnitude (Brief introduction on Maximum Credible Earthquake (MCE), Maximum Probable Earthquake (MPE), Operating Basis Earthquake (OBE), Design Basis Earthquake (DBE), and Safe Shutdown Earthquake (SSE), Upper Level Earthquake (ULE)), Duration of an Earthquake,

Recurrence Interval, Return Period, Magnitude-Frequency Relationship, Magnitude -Energy release relationship.

9.Earthquake Intensity and Vulnerability of Buildings (2 hrs.)
Earthquake Intensity, Vulnerability of Buildings and Seismic Intensity, Intensity-Magnitude Relationship; Intensity –Acceleration Relationship, Ground motion and earthquake damage assessment, Intensity and Character of Ground Shaking

10. Earthquake Spectra (2 hrs.)
Earthquake Response Spectra, Deformation Response Spectra, Earthquake Design Spectra, Damping, Time period, Peak Ground Acceleration and the Frequency of Occurrence

11.Site effects in Seismic Microzonation (3 hrs.)
Experimental Methods (Standard Spectral Ratio, H/V Noise Ratio or Nogoshi-Nakamura Technique, H/V Spectral Ratio of Weak Motion); Numerical Methods (One-dimensional Response of Soil Columns, Advanced Numerical Methods, Analytical Methods: High Frequency Techniques or Ray Methods: Boundary based techniques, Domain based techniques)), Empirical Methods (Empirical Attenuation Relationships, Empirical Green's Functions Technique (EGF))

12. Approach to Seismic Hazard Assessment (1 hr.)
Deterministic Approach, Probabilistic approach

13. Types of Seismic Hazards (1 hr.)
Liquefaction Hazard, Earthquake Induced Landslide Hazard and its Mapping, Tsunami and Seiches, Ground Rupture

14. Approaches to Seismic Microzonation (3 hrs.)
Seismic Microzonation using large earthquakes, Seismic Microzonation using weak earthquakes, Seismic Microzonation using Microseisms, Seismic Microzonation using vibration effects, Validation of Seismic Microzonation Maps, Seismic Microzoning in areas of Surface Faulting, Seismic Microzoning in areas close to fault planes

15. Seismic Hazard Mapping Scales (3 hrs.)
Types of Maps for seismic study: Geological Maps of Urban Areas, Seismic Intensity Map, Isoacceleration Map

16. Levels of Seismic Microzonation (2 hrs.)
General Zonation , Detailed Zonation, Rigorous Zonation

17. Prognosis of Credible Earthquake (3 hrs.)
Source identification and geometry, Methods for estimating maximum earthquake magnitude, Maximum Earthquake Magnitude from Rupture Area, Maximum Earthquake Magnitude from Total Displacement, Maximum Earthquake Magnitude from Seismic Moment, Maximum Earthquake Magnitude from Slip Rate, Maximum Earthquake Magnitude from Historic Seismicity, Probabilistic approach in estimating the Maximum regional earthquake magnitude, Intensity-Magnitude Relationship, Intensity –Acceleration Relationship.

18. Amplification of Ground motion (1 hr.)
Factors influencing amplification, Dynamic site periods, amplifications and response spectra estimation from a SHAKE, Assumptions in SHAKE procedure, SHAKE analysis procedure

19. Current Status of Seismic Hazard Zonation in the Himalayan Region (1 hr)
Study of Current Status of Seismic Hazard Zonation in the Himalayan Region

20. Seismic Microzonation of major urban and suburban regions of Nepal(1 hr)

References:

1. IkuoTowhata, *Geotechnical Earthquake Engineering, Springer Series in Geomechanics and Geoengineering* 2008,
2. AtillaAnsal, *Recent Advances in Earthquake Geotechnical Engineering and Microzonation,* 2004
3. Amr S. Elnashai and Luigi Di Sarno, John Willey and Sons. *Fundamentals of earthquake engineering* 2008
4. SAARC Disaster Management Centre *Seismic microzonation: Methodology for Vulnerable Cities of South Asian Countries*, 2011, New Delhi, India, 138p

Practical course

Practical 1: Locating earthquake epicenters
Objective: Seismology is the study of the waves generated by earthquakes and transmitted through the Earth. Locating where earthquakes occur is one of the most basic applications of seismology, and that information is crucial in identifying and characterizing faults and regional fault zones. This practical shows students how seismologists locate individual earthquakes. Using recent earthquake data from around the world, the exercise shows student how that data outlines the Earth's lithosphere plates and helps to characterize the motion occurring at the different plate boundaries.

Practical 2: Earthquake magnitude and intensity
Objective: This practical adds two more important concepts: earthquake magnitude and intensity. Both magnitude and intensity are expressions of the amount of energy released when a fault ruptures. The practical uses data from an earthquake to illustrate the method for calculating Richter magnitude and for mapping seismic-shaking intensity.

Practical 3: Seismic shaking and earthquake engineering
Objective: The objective of the exercise is to familiarize students with the effects of earthquakes on Earth materials and on buildings. The strength of shaking during an earthquake depends on the amplitude of seismic waves that reach the site, the earth materials at and near the surface, and the design of buildings and other structures. The objective of this practical is to outline the methods for describing and measuring seismic shaking, and for predicting its effects on human structures.

Practical 4: Conditional probability
Objective: The history of earthquake activity and faulting is vital for assessing seismic hazard, but in its undigested form, it is not particularly useful to engineers, regional planners, or the general public. Earthquake-hazard is the bridge than connects relatively raw scientific data (fault patterns, slip rates, recurrence intervals, and ages of past earthquakes) with their practical applications. The objective of this practical is to illustrate some of the basic principles by which conditional probabilities are calculated.

References:

Pinter, N, 1996. *Exercises in Active Tectonics: An Introduction to Earthquakes and Tectonic Geomorphology*. Prentice Hall: Upper Saddle River, NJ.

ELE522: Rock Mechanics (3 – 0 – 0)

Course Objectives:
A fundamental knowledge of the nature of rock, and behavior of structures under the ground motion are necessary in order to analyze and design structures rationally against seismic excitations.

Course Contents:

1. Introduction (5 hrs.)
Scope of rock mechanics; Concept of intact rock and rock mass and associated engineering properties; Rock mass discontinuities and their characterization: Geological data collection and interpretation

2. Analysis of rocks (10 hrs.)
Rock testing; Rock mass classification; Rock stresses and methods of stress analysis; Shear strength of rock and rock masses; factors affecting the shear strength of rock and rock mass, Strength of rock and rock mass, factors affecting the multi axial strength of rock and rock mass

3. Groundwater in rock (15 hrs.)
Effect of groundwater in assessing the engineering behavior of rock and rock mass, Rock dynamics; dynamic properties of rock; rock dynamics related to blasting and earthquakes, Seismic risks associated with earthquakes. Rock foundations: analytical and empirical design of rock foundations taking into consideration in situ rock conditions

4. Rock slope engineering (15 hrs.)
Types of rock slope failures, analysis of various modes of rock slope failures. Method of stabilizations of rock slopes. Design of cuts and fills in rock and other rock slope stabilization measures.

References:

1. Godman, P.E. "*Introduction to Rock Mechanics*" John Wiley, New York, 1989
2. Jager, G. "*Rock Mechanics and Engineering*", Cambridge University Press 1972
3. Stillborg, B. "*Professional user handbook for rock bolting* ", Tran Tech Publications, 1986.
4. Hock, E. and Brown, E.T. "*Underground excavation in rock*", Institute of Mining and metallurgy, 1980
5. Hock, E. and Bray, J. "*Rock slop Engineering*" Institute of Mining and Metallurgy, 1981

ELE523: Theory of Plate and Shells (3 – 0 – 0)

Course Objectives:
The objective of this course is to make the students able analyzing plate shell structure both in bending and membrane analogy.

Course Contents:

1. Introduction (5 hrs.)
Theory of plates with small and large deflections, Distinction between Plate and Shell action, Governing differential equations of thin rectangular Plates with various boundary conditions and loadings

2. Plate theory and analysis (18 hrs.)
Pure bending of Thin Plates, Curvature at a point, Circle of curvature, Moment Curvature relationships, Relationships Between Twisting moment and Twist of Surface, Symmetrical bending of thin circular plates with small deflection under axisymmetric transverse loads, Differential equation of equilibrium, Different support conditions, Plates with overhangs, Plates with co-axial circular opening, Small deflection theory for lateral loaded thin rectangular plates, Various support conditions, Naviers and Levis solution for uniformly distributed and concentrated loads, Use of numerical technique for the solution of plates, Concept of Influence Surface, Study of simply supported plates with continuous edge moment. Finite differential method, differential equation to bent surface of anisotropic plate.

3. Shell theory and analysis (22 hrs.)
Introduction to Structural behavior of thin shells, membrane and bending actions, Mathematical representation of a shell surface, Principal curvatures, Gauss curvature, Classification of shells. Membrane theory of thin shells, Stress resultant, Application to cylindrical shells under symmetrical loads and surfaces of revolution under axi-symmetric loads. Bending theory of open circular cylindrical shell with special emphasis on approximate theories of Finsterwalder and Shorer theories. Introduction to DJK, Flugg and other exact theories: Different boundary conditions for single and multiple shells, Bending theory of closed circular cylindrical shell, stiffness coefficients at free edges along; radial and rotational directions, Bending theory of spherical shells, Geckelers approximations, stiffness coefficients, Membrane theory for family of shells (Parabolic, Quaternary, Cycloid, Circular, hyperbolic).

References:

1. Timoshenko, *'Theory of Plates and Shells*", McGraw Hill Book Co.
2. Chandrashekhara*, Analysis of thin concrete shells,* McGraw Hill Book Co.
3. Ramaswamy G.S*, Design and Construction of concrete shell Roofs*, McGraw Hill Book Co.
4. Varadan T.K. and Bhaskar K. *Analysis of plates Theory and Problems*,Narr1.
5. Szilard, R.; *Theory and Analysis of Plates*; Prentice Hall; 1974

ELE526: Disaster and Risk Management (3 – 0 – 0)

Course Objectives:
The main objective of this course is to provide basic concepts for Natural disaster and to manage before and after Disaster related to structural engineering.
Course Contents:

1. Introduction (5 hrs.)
Natural Disasters: Earthquake, Floods, Drought, Coastal Hazards, Landslides, rockslides and Forest Fires

2. Elements of Engineering Seismology (10 hrs.)
Earthquake Phenomenon, Earthquake recording instruments, Introduction to Theory of Vibrations: Single degree un-damped and damped systems, elastic response to simple load functions and earthquake response spectra

3. Performance of Buildings and Structures (10 hrs.)
Main causes of damage: Intensity of earthquake forces, lack of strength and integrity in buildings, quasi- resonance, lack of ductility, lack of detailing.

4. Earthquake Effects (10 hrs.)
On ground and soil liquefaction, buildings, structures, power plants, switch yards, equipment and other lifeline structures, release of poisonous gases and radiation, Lessons Learnt from the Past Earthquakes: Case studies of important Indian earthquakes and major world earthquakes

5. Disaster Management (10 hrs.)
Salient features of disaster rescue, risk management and casualty management.

References:

1. Dr. InduPrakash., '*Disaster Management'*, Rashtra Prahari Prakashan, Sahibabad,Gaziabad.
2. Mukherjee, P.K. '*A Text Book of Geology'*
3. Jaikrishna, Chandrasekharan and B.Chandra, '*Elements of Earthquake Engg*; South AsianPublishers, New Delhi.
4. James L. Stratta, '*Manual of Seismic Design'*, Pearson Education, Singapore.
5. Manickaselvam V.K., '*Introduction to Earthquake Analysis and Design'*, DhanpatRai

Elective III, IV, and V (ELE53*)

ELE531: Pre-Stressed Concrete (3 – 0 – 3)

Course Objectives:
The main objective of this course is to provide concepts in pre-stressed concrete design of various elements using pre-stressed concrete.

Course Contents:

1. Introduction (5 hrs)
Pre-stressing systems and end anchorages, losses of pre-stress, Development of prestressed concrete, Advantages and disadvantages of prestressed concrete over RCC ,General principles of pre-stressing-pre tensioning and post tensioning –Materials used in prestressed concrete, high strength concrete ,High tension reinforcements, Different types/methods of prestressing

2. Flexure, shear, bond, bearing and anchorage (10 hrs.)
Analysis and design of members for flexure, shear, bond and bearings, Cable layouts and design of cables; Design of circular systems, domes and slabs; Analysis of Pre-stressed Bridges, (Super-structure only), Analysis of continuous beams, indeterminate structures

3. Design of presteressed concrete structure (15 hrs.)
Design of members for flexure, shear, bond and bearings, Cable layouts and design of cables; Design of circular systems, domes and slabs; Design of Pre-stressed Bridges, (Super-structure only), Design of continuous beams, indeterminate structures

4. Deflections calculation presteressed concrete structure (10 hrs.)
Introduction-Factors influencing deflections-short term and long-term deflections of uncracked and cracked members for **prestressed concrete structure**.

5. Circular prestressing (5 hrs.)
Introduction, Circumferential prestressing Design of Prestressed concrete tanks, vertical prestressing in tanks-Dome prestressing

References:

1. Lin, T.Y. and Burns, N.H *Design of Pre- stressed Concrete Structures*
2. Krishna Raju *Design of Pre-stressed Concrete Structures*

ELE532: Analysis and Design of Industrial Structure (3 – 0 – 0)

Course Objectives:
The course will help students to learn to design compatible to recent codes of practice which dealt with in this course so as to prepare the students with ability to tackle any type of industrial structure made up of steel and concrete.

Course Contents:

A. Steel Structures

1. Introduction (4 hrs.)
Structural design, history of Steel Structures, Structural System and concepts, Loading: Gravity, wind and earthquake loading, impact loading, temperature load, Erection load, Explosion and fire load, Stress types in steel: Secondary stress, multi axial stress, Fatigue stress, Expansion joints, Indian Standard rolled steel sections, ASD and LFRD design philosophies, review of rivets, bolts, pins, welds

2. Steel structural connections (4 hrs.)
Types of connections, shear connections, stiffened and unstiffened beam connection, triangular bracket plates, beam column connections, beam to beam connection; rigid frame knees, column base plate connection with column, beam splices

3. Gantry Girder (3 hrs.)
Longitudinal and Lateral forces on crane girder, Design examples

4. Transmission towers (4 hrs)
Transmission tower analysis and design, Design of Transmission tower using CAD

B. RCC structures

5. Bunkers and silos (4 hrs)
Introduction, design of square,rectangular and circular bunkers; design of silos; design of bunker and silos using CAD

6. Chimneys (6hrs.)
Parts of chimneys , Design philosophy , Stresses in RC shafts due to various loads; stresses in horizontal reinforcing bars due to shear forces; Stresses induced by temperature forces; Design of RC chimneys using charts and using CAD

7. Elevated water tanks (4 hrs)
Design example of overhead tanks and intz type tank manually and using CAD

8. Shells (6hrs)
Classification of shells, Analysis of hyperbolic and paraboloid shells, Analysis membrane forces in shells; Analysis for wind and earthquake loads in shells; Design Examples using CAD

9. Folded Plates (4 hrs.)
Analysis and design of folded plates; structural behavior; stresses in Hipped plates; Design Examples of folded plates using CAD

10. Grid or coffered floors (6 hrs.)

Approximate analysis and design of grid floors; Design of ribbed slabs; Design Examples of grid and ribbed slabs using CAD

References:

1. SyalI. C &Satindrasingh ; *Design of steel Structures*
2. Ramchandra; *Design of steel Structures*
3. RamaswamiG. S.; *Design and construction of concrete shells*
4. The steel construction institute; *Steel designer's manual*; edited by . Owen G. W

ELE533: Hydraulic Retaining Structures (3 – 0 – 0)

Course Objectives:
Students will gain of knowledge of Hydropower plants and their components. Design process overview of hydraulic structures of the hydropower plants Types of loads and their application in different components of the hydropower plants. Structural analysis and design of the various types of dams. Structural analysis, design and dimensioning of the major components of RoR type hydropower plants structural analysis and design of hydro-mechanical parts of the hydropower plants such as gates and trash racks

Course Contents:

1. Introduction to the Hydropower Plants (2 hrs.)
Types of Hydropower schemes; Storage types of hydropower plants and its components; Run of River or Peaking type of Run of River Hydropower plants and its major components; The major hydropower plants in Nepal and their special features

2.Design Process of Hydropower Components (4 hrs.)
Introduction; design Process Overview; Collecting information; Prepare design criteria; Determine loading; Preliminary layout and sizing of structure; Preliminary stability analysis; System analysis (stability, foundation pressure and frictional resistance; concrete stress); Component Analysis; Detailed Design; Drawing and Specification; Quality Control and Assurance

3. Design of Concrete dams (8 hrs.)
Types of Concrete Dams; Gravity Dams; Design Loads: (Dead loads, Geotechnical loads, Hydrostatic and hydrodynamic loads, Seismic, Ice, Wind, Snow and other loads; Load Combinations; System analysis (stability, foundation pressure and frictional resistance; concrete stress); Arch/Buttress Dams; Design Loads: (Dead loads, Geotechnical loads, Hydrostatic and hydrodynamic loads, Seismic, Ice, Wind, Snow and other loads; Load Combinations; System analysis (stability, foundation pressure and frictional resistance; concrete stress)

4. Design of Embankment Dams (6 hrs/)
Introduction and types of embankments dams; Principles of embankment dam design; Foundation Design; Slope stability analysis; Design of filters and cores; Resettlement and Deformation analysis

5. Design of RoR and PRoR hydropower plants and its components (17 hrs/)
Introduction to the RoR and PRoR hydropower plants; Design of components; Design of Weirs and Intakes; Hydraulic and Structural Design; Design of Gravel trap and Settling Basins Hydraulic and Structural design; Design of head race tunnel/channel; Design of fore bay/ surge tank; Design of Steel Penstock Pipe; Design of Anchor Blocks, Thrust Blocks and Support piers; Power house design; Tailrace tunnel\channel design

6.Design of hydro-mechanical parts (8 hrs.)
Introduction; Hydraulic gates; Introduction; types; Structural consideration; Detail design aspects; Seals, Guide and load rollers, Pivot Bearing, Ropes, Chain and other parts; Design of Vertical Lift Gates; Collecting information; Prepare design criteria; Determine loading; Design of gates and support; Design of Radial Gates; Collecting information; Prepare design

criteria; Determine loading; Design of gates and support; Design of Trash-racks Collecting information; Prepare design criteria; Determine loading; Design of Trash Rack

References:

1. P. Novak, A.I.B. Moffat and C. Nalluri *Hydraulic Structures* : Fourth Edition: School of Civil Engineering and Geosciences, University of Newcastle upon Tyne,UK and R. Narayanan Formerly Department of Civil and Structural Engineering, UMIST, University of Manchester, UK.
2. US Department of the Interior, Bureau of Reclamation *Design of Small Dams*: A Water Resources Technical Publication, Oxford and IBHP Publication Co. Pvt. Ltd. 1974
3. Engineering Monograph No. 19 Design Criteria for Concrete Arch and. *Gravity dams.* Office of Design and Construction Engineering and Research Center Denver, Colorado 80225 United States Department of the Interior Bureau of Reclamation.
4. The committee on the hydropower intake and energy division of the American Society of the Civil engineers (ASCE). *Guidelines for design of intakes for hydroelectric plants*: by Published by ASCE, 345 East 47th Street New York, 10017-2398 New York

ELE537: Repair and Retrofitting Techniques of Structures (3 –0 – 0)

Course Description and Objective:
The course will be specifically useful to improve the performance of buildings not designed incorporating the provision of seismic codes of practice and will benefit design professional.

Course Contents:
1. Introduction to the seismic evaluation and retrofit (2 Hrs**)**
Basics: Terminology; Basic principles of seismic evaluation and retrofit

2. Qualitative Methods of Seismic Evaluation (8 Hrs**)**

Rapid visual screening procedure (RVSP) and simplified evaluation of buildings; Visual inspection method and non-destructive testing (NDT) method

3. Quantitative Methods of Seismic Evaluation (8 Hrs**)**

Performance based method using nonlinear static push-over analysis (NSP) and nonlinear dynamic method of analysis (NDP); Estimation of seismic capacity (strength and ductility)

4. Methods of Seismic Retrofitting of RC Buildings (9 Hrs**)**

System completion; Strengthening of existing components; RC, Steel and FRP Jacketing; Addition of new components – frames, shear walls and braced frames; Introduction to supplemental energy dissipation and base isolation

5. Seismic Repair and Retrofitting of Earthquake Damaged Buildings (9 Hrs**)**

Schemes of temporary shuttering damages; Methods of repair and retrofitting. Steel Jacketing- design, CFRP –sheet design, Strengthening of Masonry structures

6. Seismic Evaluation and Retrofitting of RC Bridges (5 Hrs**)**
Seismic evaluation and retrofitting techniques for reinforced concrete bridges – columns/piers, cap beams, cap beam-column joint, footing

7. Case Studies in Seismic Retrofitting (4 Hrs**)**
Case studies RC buildings, masonry buildings, bridges, water tanks and gravity dams

References:

1. J. H. Bungey, “The Testing of Concrete in Structures”, Surrey University Press. 1989 2. Paulay,
2. M.J.N, T. and Priestley, “Seismic Design of Reinforced Concrete and Masonry Buildings”, John-Wiley & Sons, Inc. 1992 3. “NEHRP Handbook for the Seismic Evaluation of Existing Buildings”,
3. Federal Emergency Management Agency, Building Seismic Safety Council, Washington, D.C. FEMA 178. 1992 4. “Seismic Evaluation and retrofit of concrete building – Vol. I & II”, Applied Technology Council, California, ATC 40. 1996 5.
4. M.J.N., Seible, F. and Calvi, G.M “Seismic Design and Retrofit of Bridges”, John-Wiley & Sons Inc, Priestley. 1996 6 Penelis,

5. George G., and Kappos, Andreas J., E & FN Spon “Earthquake Resistant Concrete Structures” 1997. “Building Seismic Safety Council”, Federal Emergency Management Agency, Washington, D.C, FEMA 356, 2000, FEMA 440 / ATC 55, 2005, FEMA 310

Note: other course detail of elective courses will be submitted to Academic council of Mid – West University during run of classes in MSc. in Structural Engineering as it will depend upon Existing Faculties and students’ selection criteria.

Semester IV

Course Title: **Dissertation**
Course Code: **STR549**
Year/Semester: **II/II**
Credits: **12**
Evaluation:

Evaluators	**Proposal Defense Marks**	**Mid-Term Marks**	**Pre-Defense Marks**	**Final Defense Marks**	**Total Marks**
	10%	**40%***		**50%**	**100%**
HoD and Internal	30	40		20	90
Supervisor	-	80		70	150
External	-	-		60	60
Total	**30**	**120**		**150**	**300**

* Average of the Mid-Term Marks and Pre-defense.

Course Descriptions and Objectives
Research is an essential part of the degree being offered in Mid-West University. Students will undertake a supervised thesis which will be assessed by a Thesis Evaluation Committee, comprising of the Head of Department, Supervisor, External examiner, and Internal examiner. The thesis must relate to the subject matter and be agreed by the Graduate School of Engineering. Research essentially aims to demonstrate the students' ability and development to pursue analytical investigations on the different aspects of construction project management. Students are required to give an oral presentation on the findings of their research in the form of a seminar at a time agreed by the Graduate School of Engineering prior to the submission of the final thesis.

All the students are advised to *strictly follow the guidelines* prepared by the Graduate School of Engineering right from the preparation and submission of thesis proposal. Failure to satisfy the examiners in the specified thesis guidelines shall be considered as unsatisfactory performance and also failure in the oral presentation may lead to a failure in the thesis as a whole. The thesis committee has all the rights to reject the thesis text upon a failure of students to follow the described guidelines. So, the regular consultation with the supervisor(s) needs to be taken by the students to update their progress in thesis work. Students must complete all the courses including thesis within a period of **four** academic years. The guidelines for preparing thesis report will be provided by the Graduate School of Engineering.

Thesis Guidelines
Thesis guideline help students for the preparation of an acceptable thesis writing. Moreover, this guideline aims at maintaining uniformity in the theses being submitted in Mid-West University.
Hence, all the students are advised to *strictly follow the* guidelines right from the submission of thesis.

Evaluation Form for M.Sc. Thesis
(to be filled up by **Internal Examiner/Committee Member**)
Program: M.Sc. in Structural Engineering

Course Code : STR549
Course Title : Thesis
Credit : 12
Year/Semester : II/II
Title of the Topic :
Name of the Student : Class Roll No.:
Supervisor :

S. N.	Marking Parameter	Full Marks (%)
1.	Quality of presentation	10
2.	Problem formulation/identification/ conceptualization	20
3.	Understanding of thesis work and related theory, Methodology/Approach	20
4.	Answering to questions	10
5.	Proposal/Report formats, References style and format	20
6.	Standard of technical language, expression and style, consistencies in writing	20
	Total	**100**

Comment: ……
……

Suggestions and Recommendations:
……
……

Committee Member:
Name: ……
Post: ……
University/Organization: ……
Signature: …….
Date: ……

Evaluation Form for M. Sc. Thesis
(to be filled up by **Supervisor**)
Program: M. Sc. in Structural Engineering

Course Code : STR549
Course Title : Thesis
Credit : 16
Year/Semester : II/II
Title of the Topic :
Name of the Student : Class Roll No.:
Supervisor :

S. N.	Marking Parameter	Full Marks (%)
1.	Regularity of works (regular reporting of the progress report)	20
2.	Progress of thesis work	20
3.	Understanding of thesis work and related theory	20
4.	Student's effort and performance	20
5.	Organization of study	20
	Total	**100**

Comments:

……

……

……

Suggestions and Recommendations:

…..……

……

Supervisor:

Name: ……

Post: …….

University/Organization: ……

Signature: …….

Date: …….

Evaluation Form for M. Sc. Thesis
(to be filled up by **External Examiner**)
Program: M.Sc. in Structural Engineering

Course Code : STR549
Course Title : Thesis
Credit : 12
Year/Semester : II/II
Title of the Topic :
Name of the Student : Class Roll No.:
Supervisor :

S. N.	Marking Parameter	Full Marks (%)
1.	Problem formulation, research identification and formulation of research objectives, scope of work	15
2.	Selection of research methodology (research method and tools)	15
3.	Quality of data processing result interpretation and verification of objectives	20
5.	Quality of presentation and response to the examiner's questions	20
6.	Logical reasoning, conclusions and interpretation	10
8.	Originality of research	20
	Total	**100**

Comments: ……..
……

Suggestions and Recommendations:
……
……
…

External Examiner:
Name: ……
Post: ……
University/Organization: …….
Signature: ……
Date: ……

Guidelines (Sample Format) for M. Sc. Thesis

Research: Research refers to a search for knowledge. Research is a scientific and systemic search for new facts in any branch of knowledge. It is the pursuit of truth with the help of the study, observation, collecting the data, analyzing the data, experiment, reaching to a certain conclusion, and finding the results of the research**.** The main aim of research is to find out the truth which is hidden and which has not been discovered yet.

The General Format

Each thesis will have three categories of materials: the preliminaries, the text of the report, and the reference materials.

1. **The Preliminaries**

a. Cover page: Cover page should give information about title of the thesis, name of the institute/School, full name of the student, month and the year of the thesis completion. The title page should not contain any lines or artistic designs. Information on font type, font size, font color, page margin, and spacing between the lines is provided in the sample (see Appendix 1 and 2).

b. Title Page: Pagination should start from this page but should not appear in this page. Information regarding this page is provided in the sample (see Appendix 3).

c. Acknowledgements: It includes the acknowledgement to the people who have helped the researcher in the completion of thesis (see Appendix 4).

d. Abstract: Abstract is compulsory. Abstract should be in a summarized form and complete in itself, so that it could be possible to know the contents without reading the whole text of the thesis. The abstract is usually short and should not exceed 2 and 1/2pages. It should contain a statement of the research problem, research objectives, methods, results, discussion, conclusions and recommendations.

e. Declaration: This section declares that research/study is based on the original research works, and related works on the topic being used in the thesis is duly acknowledged through proper citation and referencing. This section is also meant for taking responsibility by the student for any error and authenticity of the data used in the thesis (see Appendix 5).

f. Recommendation: This is the recommendation of the supervisor to assure that thesis under the supervision of the supervisor meets the quality requirement (see Appendix 6).

g. Acceptance: This page is signed by external examiner, supervisor, co-supervisor (if there is co-supervisor) and coordinator of the M.Sc. program to certify that student have successfully completed the thesis work and eligible for acceptance (see Appendix 7).

h. Table of Contents: It should include the chapter, sections, sub-sections of the thesis and include following pages: acknowledgements, abstract, declarations, certificate, acceptance, list of tables, list of figures, list of abbreviations, annexes, and reference.

The title of the chapter should be in capital letters, but the sections and sub-sections headings under the main chapter title should be in capital and small letters.

i. List of Tables (if any): The term "table" applies to numerical and statistical data set in vertical or horizontal alignment. Type the table number in Arabic numerals and the titles in capital and small letters.

j. List of Figures/Illustrations (if any): It include the figures, charts, diagrams, maps and even photographic plates, if few in number.

k. List of Acronyms and Abbreviations (if any): If abbreviation and/or acronyms are needed and used in the text, a list should be provided to explain their definition or meanings.

2. **Text of the Thesis Report**

Text is a main body of the thesis report which is appropriately divided into chapters, sections and sub-sections. It contains chapters starting from the introduction followed by literature review,

methodology, results and discussions, conclusion and recommendations. Heading of all the chapters should be Upper case.

a. **Chapters Division and Subdivision**
The main body of the text should be divided into chapters. Each chapter must have a number and title. Each chapter must begin on a new page. Chapter should be numbered with either Arabic or Roman numerals. Chapter number and its title should always be placed at the center of the line and all letters should be capital. This rule also applies to the major headings of the report such as table of contents**,** appendix, and the bibliography.

b. Margins and Indention
Standard margins are required on every page of the thesis. The left margin must be one and half inches, and other margins (right, top, and bottom) must be one inch. The excess margin of half inch is required on the left-hand side to allow for binding. Paragraph indention should be uniform (five to seven spaces) to the right of the left-hand margin.

c. Spacing
Spacing of the thesis typeset must be single line spaced. Footnotes and block quotations are always single line spaced. A double space is allowed between the chapter number and its title, between the chapter title and the first line of its text.

d. Page Numbering
The preliminaries (materials that precede the first page of the first chapter) should be numbered in small Roman numerals (i, ii, iii etc.). These numerals should be centered one space below the last line of the text of the bottom of the page.

Page beginning the text (first page of the first chapter) must be Arabic numerals (1, 2, 3 etc.) without punctuation mark. This numbering continues throughout the thesis. Page numbers can be centered and placed one inch above from the bottom of the page.

The initial page of any major subdivision of the report such as the title page, the first page of the table of contents, new chapter, appendices, and the bibliography will have no page numerals placed on it, but each is counted while numbering the pages.

e. Italicization/Underlining
Foreign words and the names of the books and journals cited in footnotes and bibliography are italicized. Use either italics or underlining, but do not do both.

f. Quotations
Quotations should correspond exactly to the original in wording, spelling, and punctuation.

g. Footnotes
The purpose of a footnote is to establish the validity of evidence, to acknowledge indebtedness for an idea, and to provide cross-reference relating to the topic or the theme without disrupting the flow of the text. Every source cited in a footnote must appear in the bibliography.

3. The Reference Materials

a. Appendix: Appendix is additional information apart from the main text that is attached to the end of thesis. The main purpose of an appendix is to further explain and clarify the matter. This provides greater detail and visual example for better understanding of the main text in the form of text, graph, or picture.

Appendix serves the purpose to supplements the text. Text that cannot be put in text is placed in an appendix. Questionnaires, schedules, and discussion guidelines used to collect data for the study, documents not easily available, detailed data, and sometimes illustrations are placed in appendixes. Each appendix must have a title which should give a clear indication of the content/material that is included in the appendix.

b. Glossary (if any): A glossary is an alphabetical listing of technical and/or unfamiliar terms, with their meanings, used in a report.

Final Copy of Thesis

i. **Paper:** Thesis must be typed on one side of quality bond paper in A4 size paper.

ii. **Type Face:** The type face of the thesis should be normal, good and clear. Do not use fancy fonts. Symbols not available in computer may be neatly lettered by hand with black drawing ink.

iii. **Proof Reading:** The final copy should be correct in spelling and punctuation, and be neat in its form. It is, therefore, imperative that the candidate makes certain that the thesis she/he is submitting adheres to the formatting rules and is also free from mistakes. The candidate should proofread each page carefully and make necessary corrections whenever required.

iv. **Number of Copies and Reproduction:** The candidate should check with his program coordinator regarding the number of copies that she/he needs to submit.

The original copy may be photocopied for reproduction by using high quality photocopy machine.

v. **Binding:** The candidate is recommended not to bind her/his thesis until and unless her/his supervisor tells her/him to do so. The candidate should check with her/his program coordinator regarding the color of the cover and the information to be printed on it.

vi. **Some Final Tips:** When you start writing your thesis it is suggested that you should have (1) a good standard dictionary, (2) a good thesaurus, (3) a handbook of composition, and (4) a handbook of format/style.

Be consistent whatever you do. Whenever you are in confusion regarding your thesis format, consult your concerned program coordinator, supervisor or a person who can answer your questions confidently and correctly.

Order and Content of M.Sc. Thesis

Chapter I: INTRODUCTION

1.1 Background of the study
1.2 Statement of the Problem
1.3 Research Questions
1.4 Objectives of the study
1.5 Significance of the study
1.6 Limitations of the study

Chapter 1. INTRODUCTION: This chapter should discuss the background of the research issue, statement of the problem, research questions, research objectives, significance of the study, limitations of the study, organization of the study.

1.1 Background: Brief background should be discussed in the form of brief review of related literatures. It is essential to build statement of the problem, research questions, research objectives, significance of the study.

1.2 Statement of the Problem: This section must indicate what the problem is, why, and how it is a problem. It should be supported by evidences. It should be well connected with background section as brief as possible.

1.3 Research Questions: Research questions should be formulated based on the statement of the problem. Research questions should clearly state what answer the thesis research is looking for?

1.4 Research Objective: This section should depict that what the researcher wants to achieve from this research. Usually objective is presented as general objective and specific objectives. General objective of research should correspond to the title of the thesis. Several specific objectives could be established to meet the general objective. Specific objectives of research should match with research questions and are more or less equal to the numbers of research questions.

1.5 Significance of the Study: This section should be discussed how and who will be benefited from the study.

1.6 Scope and Limitations of the Study: Under the scope of the study, discuss focusing either geographical area or target group/population, or research area. Similarly, the expected challenges in the study that may limit the authenticity of the study should be discussed.

Chapter 2. LITERATURE REVIEW: The review of literature is a part of research, and begins from the very beginning of research work. Without the review of literature, the researcher cannot capture

the basic issues of the study. Literature review provide the researcher an overview of published materials on the topic of interest which have produced by the scholars and researchers. It is quite important to uncover what is already known in the body of knowledge prior to initiating any research (Hart. 1998). Hence, it is a critical endeavor for any academic research in theoretical and conceptual progress (Shaw, 1995; Webster and Watson, 2002). In the context of research, it helps the researcher to understand what is already known about the topic and find the gap that researcher will bridge.

Chapter 3. RESEARCH METHODOLOGY: Research methodology describes the detail procedure of conducting research with the justification of selecting methodology to meet the research objectives. It should include research design (historical research, experimental research), research approaches (qualitative and quantitative), study area, study population, sample selection (sample selection methods), sample size, method of data collection (key informant interview, focused group discussion, questionnaire survey, observation) and data analysis.

3.1 Rationale for the selection of Study Area
3.2 Sampling Techniques
3.3 Collection of Data
3.4 Data Processing Procedures
3.5 Data Analysis Procedures
3.6 Reliability and Validity of Data

Chapter 4. RESULTS AND DISCUSSIONS/ANALYSIS AND INTERPRETATION OF DATA: Raw data conveys little information, as it must be compiled, analyzed and interpreted carefully. Data analysis is an important stage of the research process. The analysis of data consists of organizing, tabulating, performing statistical analysis and drawing inferences (Pant 2010). This chapter depicts the findings of the study in logical sequence in line with specific objectives.

4.1 Analysis of Data
4.2 Findings
4.3 Interpretation of Data

Chapter 5. CONCLUSIONS AND RECOMMENDATIONS: Conclusions is integration of various issues covered in the body of the text. Conclusion should be drawn based on the findings in line with specific objectives. Conclusion should include any implications resulting from the discussions and making policy recommendation as well as the need for further research. Recommendations should be based on the conclusion drawn. Conclusion and recommendation of the study must be limited within the scope of the thesis research.

5.1 Conclusions
5.2 Recommendations

Text Citation: when making reference to an author's work in the text, their name is followed by the year of publication of their work. For instance, when writing for a professional publication, it is good practice to make reference to other published work. This view has been supported in the work of Cormack (1994).

When mentioning a particular part of work, and making direct reference to this, a page reference should be included e.g. Cormack (1994, pp.32-33) states that "When …… works".
Reference: All the works cited in the text should be listed alphabetically by author or authorship' regardless of the formats (whether books, journal articles or website etc.). In the case of several works from one author or source they should be listed together but in date order with the earliest work listed first.

Researcher need to provide evidence and support her/his arguments while writing the thesis report. Researcher should refer earlier publications such as journals, books, reports, thesis, and other materials from website. Hence, referencing is to give credit to the authors, or organizations for using their work in the research thesis. It provides the evidence to the reader and enables them to locate the reference easily. It is also necessary to avoid being accused of plagiarism, which is an academic offense and can have a negative impact on the evaluation of her/his research.

Plagiarism: Plagiarism means copying or using other' ideas or work without acknowledging the original source and/or author. Plagiarism include copying other's work with or without permission; using assignment from different source; copying and pasting text or images without referencing the source; quoting or putting the work of others in her/his words without referencing the source. Plagiarism can be in a variety of forms, from directly quoting someone without acknowledgment, copying and pasting from any available sources including internet, changing some words without acknowledgment and etc. This type of activities of a student will be considered as a serious offence and the university/course instructor will take serious action.

References/Bibliography: References includes only the relevant and cited sources used in the preparation of the report. Bibliography is comprehensive listing of works on a subject and it may not be limited to literature cited in the text, and thus provides additional sources of information whereas

In thesis and dissertation, researcher should use only the References. Sources not relevant and not cited, even if they were consulted, should not therefore be included in the References; but they can be included in Bibliography. Following style has been suggested for bibliographical entries.

Write the last name of the author, a comma and her/his first and middle names as they appear in the work followed by the date of publication in parentheses and a full stop. Give the full citation of the work with every important word of the title in capital letters and provide the address and full name of the publisher. Some examples of bibliographic entries are given below:

A book by a single author
Kothari, C.R. (2000). *Research Methodology: Methods & Techniques*. Reprint. New Delhi: Wishwa Prakashan.

A book by two authors
Wolff, H.K. & Pant, P.R. (1999). *A Handbook for Social Science Research and Thesis Writing*. Buddha Academic Publication.

A book by corporate authors
National Planning Commission (1972). *The Eighth Plan, Kathmandu*: National Planning Commission.

Translation of another author's book
Klinchin, A.I. (1957). *Mathematical Foundation of Information Theory*. Translated by Silverman, R.A. and M.D. Friedman. New York: Dover.

An article in a journal
Thakuri, S., Dahal, S., Shrestha, D., Guyennon, N., Romano, E., Colombo, N., & Salerno, F. (2019). Elevation-dependent warming of maximum air temperature in Nepal during 1976–2015. *Atmospheric Research*, *228*, 261-269.

A published thesis/dissertation
Kanel, N.R. (2002). *Life-cycle Analysis of Household Composition and Family Expenditure Behavior*. Ph.D. Dissertation submitted to University of Hawaii, and published by University of Michigan Microfilms Publication (USA).

A published report
World Bank (2004). *World Development Report 2004*. Washington, D.C.: The World Bank.

Note: The names of books and journals are always italicized, and the articles and reports are put in double quotes.

Appendix 1: Sample of cover page

MID-WEST UNIVERSITY
GRADUATE SCHOOL OF ENGINEERING

Master's Thesis

Quality Management System in Building Construction Industry
(A case study of Building Construction Industry at Birendranagar, Surkhet, Nepal)

Hari Pant

Department of Civil Engineering
Birendranagar, Surkhet, Nepal

August, 2021

No Pagination
(should not be a page number)

Appendix 2: Sample of side print

Quality Management System in Building Construction Industry

Hari Paut

2021

Font size can be adjusted to fit the space but should be bold, Non italic and without underline.
Color: Golden

Year of Thesis completion

Appendix 3: Sample of Title Page

MID-WEST UNIVERSITY

GRADUATE SCHOOL OF ENGINEERING

Quality Management System in Building Construction Industry
(A case study of Building Construction Industry at Birendranagar, Surkhet, Nepal)

Hari Pant
[Class Roll Number]

A thesis submitted in Partial Fulfillment of the Requirement for
the Degree of Master of Science (M.Sc.) in (Name of Degree) awarded by
Mid-West University

Department of Civil Engineering
Birendranagar, Surkhet, Nepal

August, 2021

Appendix 4: Sample of Acknowledgement

Acknowledgements
(Times New Roman 12 Pts., Normal Bold)

Thank and acknowledge all the personnel and institutions who have provided their valuable time and input to make research work a reality. Try to acknowledge all those who have been engaged directly and indirectly in the preparation of thesis report. Make it within a page.

Appendix 5: Sample of Declaration

Declaration

(Times New Roman 12 Pts, Normal, Bold)

I, hereby, declare that this study entitled [put title of the thesis in bold ……] is based on my original Research work. Related works on the topic by other researchers have been duly acknowledged. I owe all the liabilities relating to the accuracy and authenticity of the data and any other information included hereunder.

Signature
Name of the student:
Date:

Appendix 6: Sample of Recommendation

Recommendation
[Times New Roman 12 Pts, Normal, Bold]

This is to certify that this thesis entitled [Put the title of the thesis here in bold …..] prepared and Submitted by [Put name of the student here in bold …..] in partial fulfillment of the requirements of the degree of Master of Science (M. Sc.) in [Put name of degree) awarded by Midwestern University, has been completed under my supervision. I recommend the same for acceptance by Midwestern University.

Signature
Name of the Supervisor:
Organization:
Designation:
Date:

Appendix 7: Sample of Acceptance

Acceptance
(Times New Roman 12 Pts, Normal, Bold)

This thesis entitled [put title of the thesis here in bold ……] prepared and submitted by [Put name of the student here in bold] has been examined by us and is accepted for the award of degree of Master of Science (M.Sc.) in [Put name of the program] by Midwestern University.

[Name of the external examiner in Bold] External Examiner	[Signature]	[Date signed]
[Name of the thesis supervisor] Supervisor	[Signature]	[Date signed]
[Name of the thesis co-supervisor] Co-supervisor (If applicable)	[Signature]	[Date signed]
[Name of the Head of Department] Department of Civil Engineering	[Signature]	[Date signed]