Department of Earth Science and Petroleum

College of Science

Salahaddin University-Erbil

Subject: Brittle Structural Geology

Course Book – 3rd year student- 1st semester

Lecturer's name: MSc. Soran Hasan Arab Syan

Academic Year: 2023/2024

Course Book

1. Course name	**Ductile Structural Geology**
2. Lecturer in charge	**Soran Hasan Arab**
3. Department/ College	**Earth Sci. and Petroleum/ college of Science**
4. Contact	**e-mail: soran.syan@su.edu.krd** **Tel: (07504916608)**
5. Time (in hours) per week	**Practical: 8**
6. Office hours	**26**
7. Course code	
8. Teacher's academic profile	**2020- to date**--- PhD student in Structural Geology in Earth Sci. and Petroleum Dept. **2015-2020** MSc. In Structural Geology, Geology Dept. Salahaddin Univ.-Erbil **2004-2008** B.Sc. in Geology, Geology Department
9. Keywords	**Fold, fault (normal, reverse, strike-slip), Fracture, Joint, stress, tectonic analysis,**

10. Course overview:

The opportunity to collect facts, examines information, and draw conclusions in a scientific manner frequently result in comprehension and visualization. Learning is much more than the accumulation of knowledge; it is also the understanding that comes from "doing". In the laboratory we hope students will refine the critical and creative thinking skills that are vital to students' effective participation in a society.

11. Course objective:

The first steps in the study of geological structures are largely geometrical. This was true in the initial stages of any field investigation, and in the education of structural geologist. This concern for geometry includes the methods of describing and illustrating the form and orientation of geologic structures, and the solution of various dimensional aspects of these structures.

Another aim, method of presenting and analyzing geologic data, including geological maps, geological cross section and block diagram are given.
The final purpose stereographic projection and the stereo net, and the methods of plotting and solving angular problems, and many of the same elementary problems as well as few advanced ones are solved with their use.
With this as a background, the students received basic principles in practical structural geology

Class divided to five groups, each group has three hours per a week. About forty to fifty minutes, at beginning of each laboratory there is explanation and

solving an exercise; this leads students with the help of instructor to solve remain exercises and present a report at the end of each lab. In next week Laboratory, a correct report with their degree will return to students. Absent student in the Laboratory without any formal reason will take nothing in report of this week laboratory. All Groups of students together will have three monthly examinations, each one from seven to eight laboratory exercises in previous determined time outside schedule of weekly laboratory.

Required equipments

0.5 mm mechanical pencils, colored wood pencils, ruler, protractor, triangles, graphic and trace papers, laboratory sheets and stereographic net are supplied by instructor.

13. Forms of teaching

Data-Show, white board and Overhead

14. Assessment scheme

The students are required to do two closed exams during the course period. All exams have 25% marks; the quiz tests have 5% marks, the attendance, classroom, activities, absence count and reports 5% marks.

So that the final grade will be based upon the following criteria:

Reports, Quiz and participation: 15%

Monthly exams: 20%

Total of practical: 35%

15. Student learning outcome:

Each student should know the basic principles and have actual practice with the plotting different type of structural data such as linear and planar geometrical elements of structural features. In addition, they should be familiar with geometrical and stereographic projection procedures andreading and constructing map and cross sections

16. Course Reading List and References:

The student can find additional information and examples in the following references

1. Billings, M.P., 1972, **Structural geology**, Frentice-Hall, Inc.New jersey, 606P.
2. Bradshaw, M.J.and Jarman, E.A., 1969, Geological **Map Exercises**, the English Universities PressLimited, London, 32P.
3. Richard J Lisle, 2004, Geological **structures and maps: A practical guide**, third edition,elesiver.
4. Richard H.Groshong,Jr. ,2006,**3-D Structural Geology :A practical guide to Quantitative surface and subsurface map interpretation** , 2nd ed. ,Springer.
5. Phillips, F.C., 1971, **The use of stereographic projection in structural geology**: 3rd ed.,Edward

Arnold,London,90P.
6. Ragan, D.M.1983, **Structural Geology: An Introduction to Geometrical Techniques**,Join Wiley&Sons,New York,393P.
7. Rowland,S.M.,Duebendorfer, E. M. andSchiefelbein,I.M.,2007,**Structural Analysis and Synthesis: A Laboratory Course in structural Geology**:3rd ed.,Blackwell publishing Ltd.301P.
8. Simpson, B., 1968, **Geological Maps**:Pergamon Press Ltd.,Heading Hill Hall,Oxford,98P.
9. Suppe,.1985.**Principles of Structural Geology**.Prentice-Hall,Engiewood cliffs,New jersey,537P.

17. The Topics:	**Lecturer's name**
Theory	Dr. Hasan ex: (2 hrs) ex: 11/11/2023
18. Practical Topics (If there is any)	
Course Program (Practical ductile structural Geology) Practical ductile structural geology embraces forteen laboratories which cover basic topic. Below name of each laboratory presented and their detail items as well as objectives are illustrated in inclined writing **Week1: Stereographic projection: Line** Attitude of line: geometrical elements measurement, pitch, trend. Forms of attitude: three digital form, quarter form; right handed method **Week2: Stereographic projection: PLane** Attitude of plane: geometrical elements measurement, Strike Dip direction and Dip angle, Right Hand rule method. Forms of attitude: convensions **Week3: projecting a line onto a plane & finding the pitch (rake) angle** plotting the line onto a plane and finding the rake (pitch) angle, methods for writing the rake angle. **Week4: True Dip and Apparent Dip** Streographic projection-Apparent dip and True dip. Finding apparent dip. construction and finding true dip and strike. Finding true dip of a plane from two known apparent dips. **Week5: The angle between two planes and the attitude of intersection line between two planes.** Determining the angle between a pair planes (A,B) stereographically, and the attitude of intersection line between two planes **Week6: Analysing folds: Inter-limb angle and orientation of folds** finding the folding angle, interlimb angle, orientation of hinge line (fold axis) or beta axis, and Attitude of the axial planes of the folds. **Week7: Analysing folds: Beta (β) and Pi (π)-diagrams.**	Soran Hasan ex: (2 hrs) ex: 25/11/2023

Stereographic projection-Pi and Beta diagrams. Perfect cylindrical fold, cylindrical fold, sub-cylindrical fold, non-cylindrical fold, tightness of folds (fleuty, 1964), calculating the mean orientation of fold axes. **Week8: Analysing fractures: Geometrical Classification of joints.** Classification of the joints based on their relations with the geometric axes a,b, and c by stereographic projection. Find σ1, σ2 and σ3 for conjugate shear joints. **Week9: Paleostress analysis** Geometrical classification of shear joints; bisector of the acute angle; bisector of the obtuse angle; intersection line of two set of joints; principal stress directions. **Week10: Structural Software: Stereonet windows** Recognition of the folds from geological map, symmetrical folds, asymmetrical folds; finding attitude of hinge line, amplitude and wave length of the fold; drawing cross section for folded strata **Week11: Structural Software: Rock Science Dips, Geocalculator** Geological map interpretation, symmetrical plunged fold, asymmetrical plunged fold, construction of hinge line, finding attitude of hinge line. **Week12: Rockware software**	

19. Examinations:

What are the main types of convention?

1-The azimuth method is measured clockwise from north and range between 0-360.

2-The quadrant method is based on four 90°quadrants.

Compare between dip angle and plunge**.**
-Give three example of planar structural element.

How can you determine vertical displacement of the fault?

What is the difference between trend and strike?
Trends used to describe the direction of linear structures
How can you determine vertical displacement of the fault?

20. Extra notes:

The student must learn some of new structural geology lectures and software that help them to practise the labs.

21. Peer review پێداچوونەوەی هاوەڵ

This course book has to be reviewed and signed by a peer. The peer approves the contents of your course book by writing few sentences in this section.
(A peer is person who has enough knowledge about the subject you are teaching, he/she has to be a professor, assistant professor, a lecturer or an expert in the field of your subject).

Dr. Hassan Ghazi Kak-Ameen