Lever rule is used for the evaluation of the weight / atomic fraction of phases at a particular composition using the equilibrium phase diagram. The weight or the atomic fraction of the phases depends on the x-axis (abscissa) of the equilibrium phase diagram. The most commonly used phase diagram is the Iron – Cementite phase diagram. It could be used for the calculation of amount phases in Steel / Cast Iron samples with a particular carbon content. Tie line is taken just below the Eutectoid temperature line of 727 Degree Celsius. The approximations taken in the app: Eutectoid Composition: 0.8 wt% Carbon, Maximum solubility of carbon in Ferrite: 0.025 wt% Carbon, Maximum solubility of carbon in Austenite: 2.14 wt%, Cementite: 6.67 wt% C. Amount of phases are displayed as percentage. The proeutectoid phases mean the phase that has formed before the transition of the eutectoid temperature. Normally in the Iron – Cementite phase diagram till 2.14 wt% carbon it is considered as Steels and above 2.14 wt% carbon it is said to be cast iron. Accordingly, the app has been designed for determination of the type for the entered carbon content.
\n\n© Bhargav Techno.\n\n

AC3 and ACm are temperature lines in the Iron - Cementite phase diagram. The AC3 temperature line is for the steel with carbon 0 wt% to 0.8 wt%. At 0.8 wt% C it is Eutectoid Steel so it directly converts to Austenite there is no two – phase region. The ACm temperature line is for the steel with carbon above 0.8 wt% to 2.14 wt%. Above 2.14 wt% it is Cast Iron. The AC3 line is the temperature at which transformation of Ferrite to Austenite is complete during heating. ACm line is the temperature at which in hypereutectoid steels the solution of Cementite in Austenite is completed during heating. In this app the temperature is determined by the mathematical method of congruent triangles. We get the approximate values of the AC3 and ACm temperature in Degree Celsius. The app is mainly designed for budding Metallurgical Engineers for the basic understanding of the Lever rule and Iron cementite phase diagram.
\n\n© Bhargav Techno.\n\n

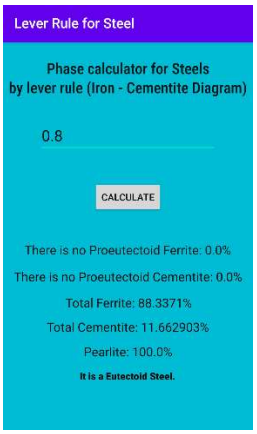
The two important motives of this app are for

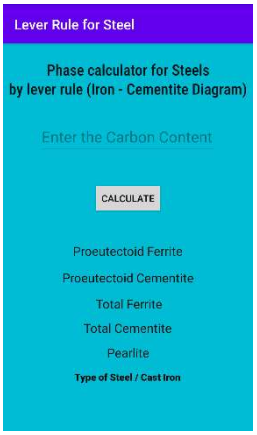
1. Helping Budding Metallurgical Engineers,
2. Factory workers/ researchers in the Metallurgy and Materials Engineering Field.

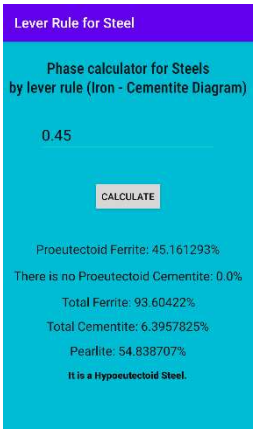
The app has two calculators one for the calculation of phase amounts and the other as a temperature calculator. The app gets only the carbon content of Steel / Cast Iron as input from the user and directly the phase amounts are determined. This is according to the Iron – Cementite phase diagram which is a widely used phase diagram by the Metallurgical Engineers. With respect to this diagram the carbon content is input and then accordingly the phases present in the given steel / cast iron is determined along with their percentages. The second calculator is for the AC3 and ACm temperature determination for the entered carbon content of Steel. These are important temperature lines in the Iron – Cementite Diagram. Lever rule is the method used for the phase calculation and simple mathematical method of congruent triangles is used for the temperature calculation. This app will surely help the budding Metallurgical Engineers to get a proper understanding of these concepts. The app has also sample questions and answers for testing the students understanding. There is also optical microscopy images of ferrite and pearlite microstructures in the app so that people can get an idea of what would be present in their steel. The app also has proper description for the performed process. Currently only the final development of a test which users could attend and see their level of understanding is being incorporated with this app.

DEVELOPMENT PHASE OF LEVER RULE CALULATOR APP.

In C++ the code for the lever rule was developed first. Then the idea of app came up. First the app was planned only for a phase calculator which calculates the phase amount when the carbon content is entered. The screenshot images for same is given below after initial development.

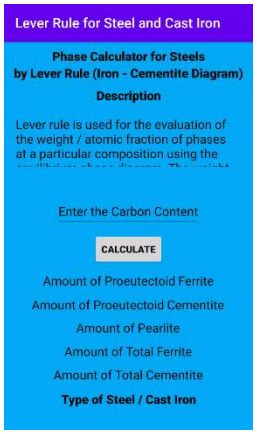


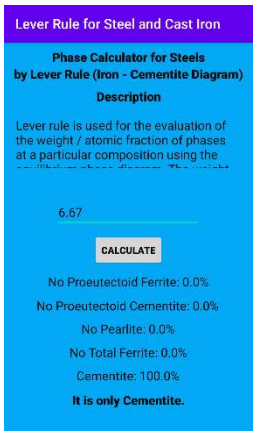


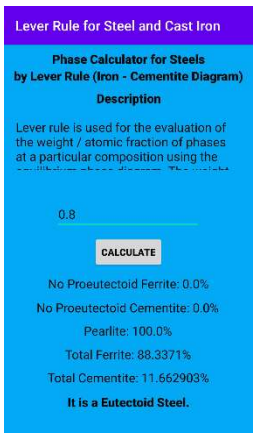


The actionbar was not good at the top. But as I was just a starter with this android app development I did not have great ideas and I thought of inclusion of the description for the

calculator by inclusion of the scrollbar. The screenshot images below show the stage two of the app.

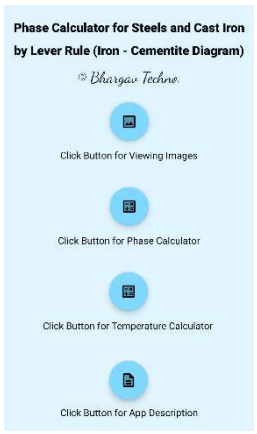


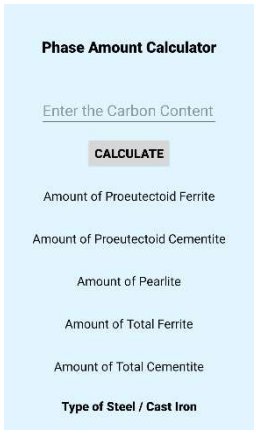


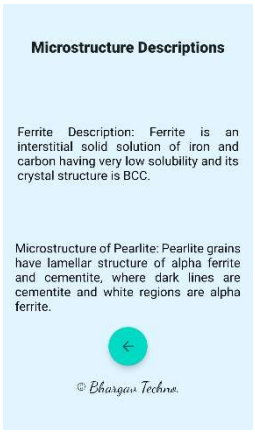


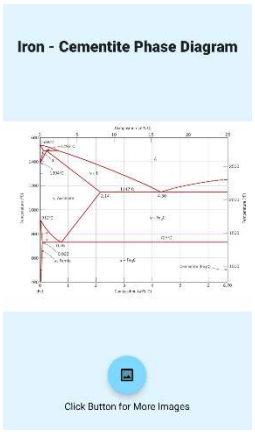
The scrolling description would not be comfortable for the readers and it was not giving a great appeal for the app's user interface. Hence after some sessions on android app development, I took up the next stage for developing the app. Now better options of inserting buttons and images for better understanding were opted. The below screenshot images show the improvement made.

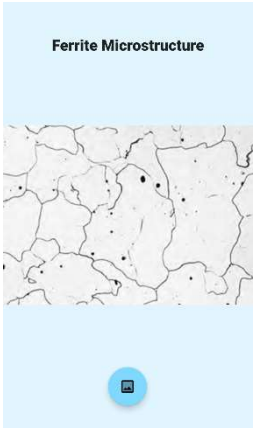
The action bar was also removed from the app so that the user interface would look more better.

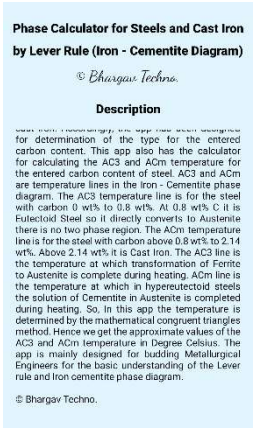


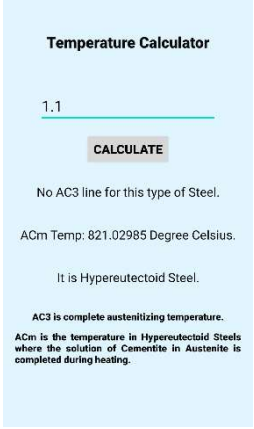




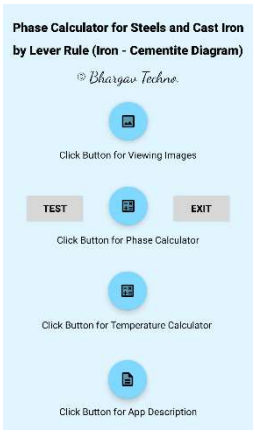








The app looks now complete but some changes were required. The description page is not good hence the description pages were split into two. An app EXIT button would be more helpful which was also inducted and a question and answer page was also included. Some more technical issues were to be addressed like the app must be ensured to work only in the portrait mode and also the app must be able to work in devices that are large. The app mainly targets phones that are 5 inches and above. As presently phones are large only. Hence accordingly the horizontal constraint was setup. This would ensure that the contents are placed properly. The below screenshots of the app in the final stage of development.



Test your knowledge

1. What is the crystal structure of ferrite ?

(a) Face Centered Cubic

(b) Body Centered Cubic

(c) Hexagonal Close Packed

(d) None of these

2. Eutectoid steel has _____.

(a) 100% Pearlite

(b) 75% Pearlite

(c) 50% Pearlite

(d) None of these

NEXT

Test your knowledge

3. Amount of Pearlite difference between 0.1 wt% and 0.6 wt% carbon steel ?

(a) 75.5 %

(b) 60.5 %

(c) 61.0 %

(d) 64.5 %

4. What is the amount of Total Ferrite in 0.45 wt% carbon steel ?

(a) 93.60 %

(b) 90.00 %

(c) 75.00 %

(d) 45.16 %

VIEW ANSWERS

Answer Key

1. (b) Body Centered Cubic

2. (a) 100% Pearlite

3. (d) 64.5 %

4. (a) 93.60 %

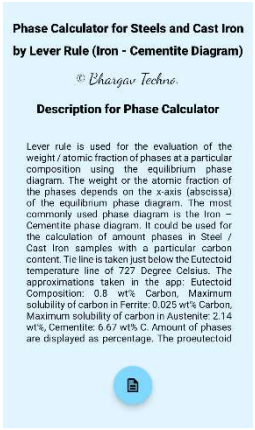
EXIT APP

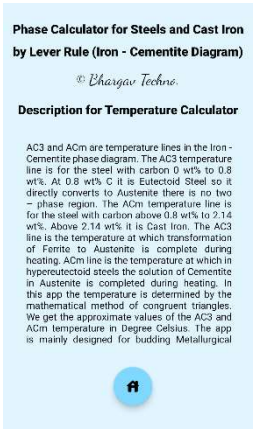
Hope you got all answers correct.

Microstructure Descriptions

Ferrite Description: Ferrite is an interstitial solid solution of iron and carbon having very low solubility and its crystal structure Body Centered Cubic.

Microstructure of Pearlite: Pearlite grains have lamellar structure of alpha ferrite and cementite, where dark lines are cementite and white regions are alpha ferrite.





These screenshots show that the app is in the final completion stage and requires a development of more interactive interface like a test module, so that people can attend it and know their score after attempting the test. The final phase is being developed and the app has to be tested and debugged continuously for more better performances. This ensures that the final app is flawless and could be released accordingly. Even the app background and foreground were properly designed and only TEXT (Lever Rule Calculator) with the app name was used as foreground.