Jackfruit Level Problem

Program to calculate darcies friction factor , for various values of Re(4*10^4 to 10^8) and for relative roughness ratio(0 to 0.05) , using Colebrook's equation , draw the moody chart

Darcy's Friction Factor:
Darcy's friction factor (f) is a dimensionless number used in the Darcy-Weisbach equation to quantify frictional losses in pipe flow.
It depends on flow regime (laminar or turbulent), pipe roughness, and Reynolds number.
For laminar flow, f=64/Ref but for turbulent flow, it is determined empirically.
It helps in calculating pressure drops in internal flows

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e/D (Relative Roughness):
Relative roughness is the ratio of the pipe's surface roughness (e) to its diameter (D).
It is a key parameter in determining friction losses in turbulent flow.
Higher e/D means rougher pipes, increasing flow resistance.
It influences the value of the Darcy friction factor in turbulent conditions

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Moody's Chart:
Moody's chart is a graphical representation of the Darcy friction factor versus Reynolds number for various relative roughness values (e/D).
It combines experimental data to cover both laminar and turbulent flow regimes.
Used to determine friction factor without complex calculations.
Essential tool in fluid mechanics for pipe flow analysis.

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Matlab Code

```
clc;
clear;
close all;

% Constants
Re_range = logspace(3, 8, 100);      % Reynolds
number range (4e4 to 1e8)
epsilon_D = linspace(0, 0.05, 5);  % Relative
roughness range (0 to 0.05)

% Initialize matrix to store friction factors
f_values = zeros(length(Re_range),
length(epsilon_D));

% Colebrook-White equation solver using fixed-
point iteration (Newton-Raphson method)
for i = 1:length(epsilon_D)
    for j = 1:length(Re_range)
        % Define the initial guess for f
(initial guess can be anywhere within the range
0.02 to 0.04)
        f_guess = 0.02;

        % Relative roughness for the current
case
        roughness = epsilon_D(i);

        % Reynolds number for the current case
        Re = Re_range(j);

        % Start fixed-point iteration
        tolerance = 1e-6;  % Set a tolerance
level for convergence
        max_iter = 100;    % Maximum iterations
        iter = 0;
```

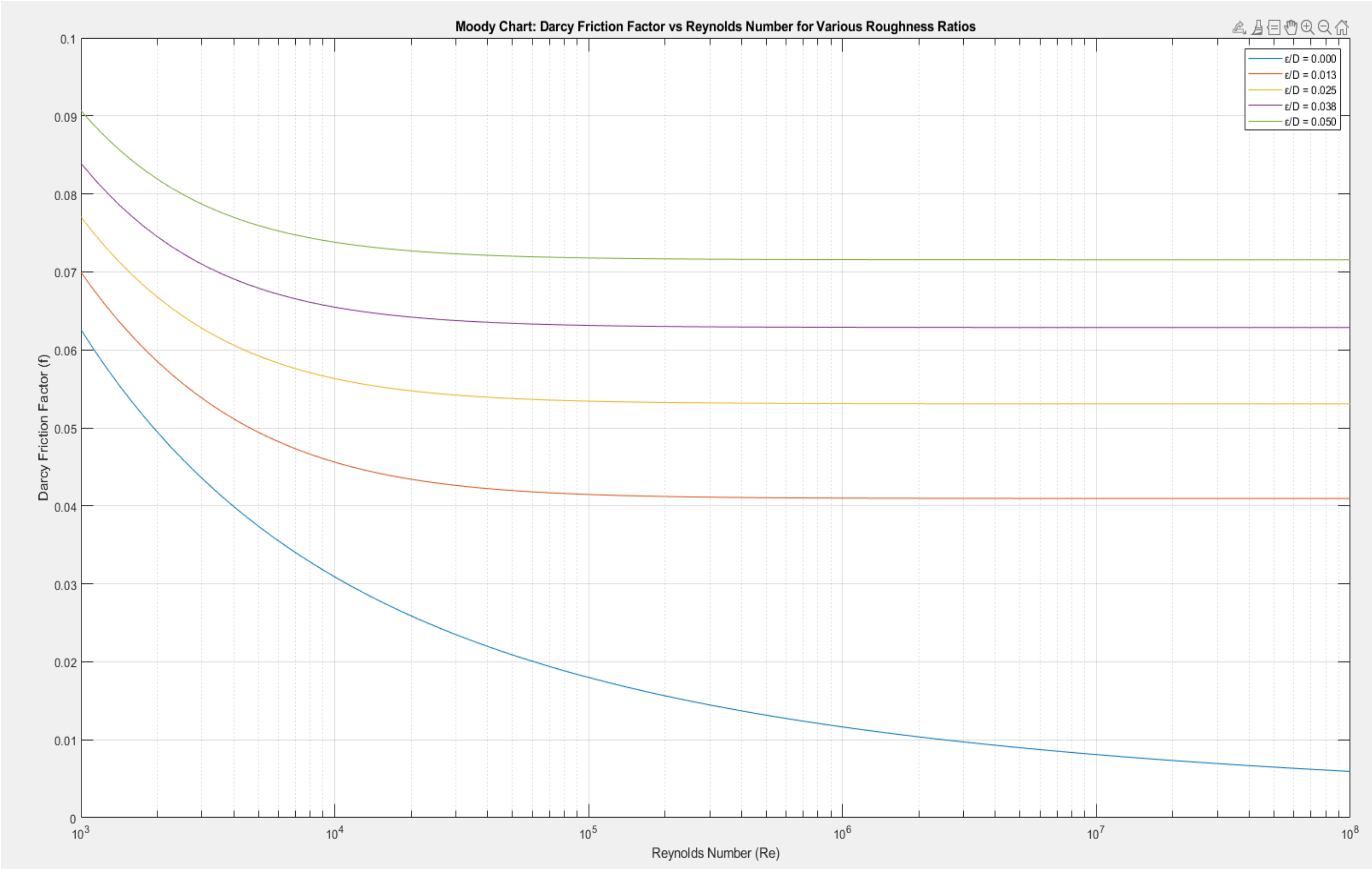
```
        % Iterative solution for Colebrook
equation
        while iter < max_iter
            iter = iter + 1;
            % Update guess for f using the
Colebrook equation
            f_new = 1 / (-2 * log10((roughness
/ 3.7) + (2.51 / (Re * sqrt(f_guess)))) )^2;

            % Check if the difference between
the new and old guess is within the tolerance
            if abs(f_new - f_guess) < tolerance
                break;
            end

            % Update guess for next iteration
            f_guess = f_new;
        end

        % Store the final friction factor for
the current Reynolds number and roughness ratio
        f_values(j, i) = f_new;
    end
end

% Plotting the Moody chart
figure;
semilogx(Re_range, f_values);
xlabel('Reynolds Number (Re)');
ylabel('Darcy Friction Factor (f)');
title('Moody Chart: Darcy Friction Factor vs
Reynolds Number for Various Roughness Ratios');
legend(arrayfun(@(x) sprintf('ε/D = %.3f', x),
epsilon_D, 'UniformOutput', false));
grid on;
```



Moody Chart: Darcy Friction Factor vs Reynolds Number for Various Roughness Ratios
Darcy Friction Factor (f)
Reynolds Number (Re)
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
10^3
10^4
10^5
10^6
10^7
10^8
ε/D = 0.000
ε/D = 0.013
ε/D = 0.025
ε/D = 0.038
ε/D = 0.050

Moody Chart – Key Inferences

1. **Laminar Flow (Re < 2000)**
   - Friction factor is **independent of roughness** and follows the relation:
     f=64/Ref
   - The flow is smooth and predictable.
2. **Critical/Reynolds Transition Region (Re ≈ 2000–4000)**
   - Flow transitions from laminar to turbulent.
   - This region is **unstable and unpredictable**; friction factor varies erratically.
   - Avoid designing systems to operate here.
3. **Turbulent Flow – Smooth Pipe (high Re, low ε/D)**
   - For **hydraulically smooth pipes**, **f depends weakly on Re**, but not on roughness.
   - Friction factor decreases as Re increases, and curves converge for low ε/D.
4. **Turbulent Flow – Rough Pipe (high Re, high ε/D)**
   - For **hydraulically rough pipes**, **f becomes independent of Re** and **depends only on ε/D**.
   - At very high Re, curves become horizontal → fully rough regime.
5. **Curve Behaviour and Intersection**
   - All curves start from the same laminar region and then split based on roughness.
   - At high Re, **rough pipes "flatten out"** sooner, and the impact of Re diminishes.

What It Tells Us Practically

- Whether viscous or roughness effects dominate.
- How much head loss to expect for a given flow condition.
- Whether pipe polishing (smoother pipe) or operating at higher Re will significantly reduce losses.
- Critical design decisions: whether to treat flow as laminar, transitional, or turbulent.

Reference

Notes of Dr. V Krishna
Chatgpt
The Internet