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// Program to approximate pi using N terms of the Leibniz series
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// P305 UH Manoa

using namespace std;
#include <iostream>
#define _USE_MATH_DEFINES
#include <cmath>

double percent_error(double x){ // Defines percent error function for pi
    return 100*abs(x - M_PI)/M_PI;
}

int pi_approx_Leibniz(){          // Define function for approximating pi

int Nmax;                        // Define max term variable
cout << "Enter the number of terms: ";
while(true){                    // Catches negative integer selection
    cin >> Nmax;
    if(Nmax < 0){
        cout << "Please enter a positive integer: ";
    }
    else{
        break;
    }
}

double Lsum = 0.0;              // Defines sum value of Leibniz series

for(int j = 1; j <= Nmax; j++){
    double Lterm = 4*pow(-1, j+1)/(2*j-1);
    Lsum += Lterm;
}

cout << "For N = " << Nmax << " terms, the approximation for pi is" << endl << endl;
cout << "Pi = " << Lsum << endl << endl << "and the percent error is" << endl << endl;
cout << "Pi_err = " << percent_error(Lsum) << endl << endl;

}

int pi_approx_Wallis(){          // Define function for approximating pi

int Nmax;                        // Define max term variable
cout << "Enter the number of factors: ";
while(true){                    // Catches negative integer selection
    cin >> Nmax;
    if(Nmax < 0){
        cout << "Please enter a positive integer: ";
    }
    else{
        break;
    }
}

double Wpro = 1.0;              // Defines product value of Wallis

for(int j = 1; j <= Nmax; j++){
    double Wterm = (2.0*j)*(2.0*j)/(2.0*j-1.0)/(2.0*j+1.0);
    Wpro = Wpro * Wterm;
}

cout << "For N = " << Nmax << " factors, the Wallis approximation for pi is" << endl << endl;
cout << "Pi = " << 2.0*Wpro << endl << endl << "and the percent error is" << endl << endl;

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    cout << "Pi_err = " << percent_error(2.0*Wpro) << endl << endl;
}

int main(){

    cout << "This program approximates pi using integer N terms of the Leibniz series or integer N
    factors in the Wallis formula." << endl;

    char choice = 'n';
    char answer = 'n';
    do {
        cout << endl << "Which approximation for pi would you like to use?" << endl << "Leibniz (L)
    or Wallis (W)? ";
        cin >> choice;
        if((choice == 'l') || (choice == 'L')) {
            pi_approx_Leibniz();
        }
        else if((choice == 'w') || (choice == 'W')){
            pi_approx_Wallis();
        }
        else{
            cout << endl << "Invalid option. Terminating..." << endl << endl;
            return 0;
        }
        cout << "Would you like to try another value? (Press Y): " << endl;
        cin >> answer;
        } while ((answer == 'y') || (answer == 'Y'));

    cout << endl << "Good bye!" << endl << endl;

    return 0;

}
```