12.27

Bhargav - EE25BTECH11013

September 29, 2025

Question

Question:
1200 men and 500 women can build a bridge in 2 weeks. 900 men and 250 women will take 3 weeks to build the same bridge. How many men will be needed to build the bridge in one week?

Solution

Let one man complete work in x weeks and one woman complete work in y weeks

In one week a man can complete $\frac{1}{x}$ work and woman can complete $\frac{1}{y}$

$$\frac{1200}{x} + \frac{500}{y} = \frac{1}{2} \tag{1}$$

$$\frac{900}{x} + \frac{250}{y} = \frac{1}{3} \tag{2}$$

$$\begin{pmatrix} 1200 & 500 \\ 900 & 250 \end{pmatrix} \begin{pmatrix} \frac{1}{x} \\ \frac{1}{y} \end{pmatrix} = \begin{pmatrix} \frac{1}{2} \\ \frac{1}{3} \end{pmatrix} \tag{3}$$

Solution

This can be converted into an augmented matrix and can be solved by Gaussian elimination:

$$\left(\begin{array}{cc|c} 1200 & 500 & \frac{1}{2} \\ 900 & 250 & \frac{1}{3} \end{array}\right) \xleftrightarrow[R_2 \leftarrow R_2/125]{R_2 \leftarrow R_2 - 3R_1/4} \left(\begin{array}{cc|c} 1200 & 500 & \frac{1}{2} \\ 0 & 1 & \frac{1}{3000} \end{array}\right) \tag{4}$$

$$\xleftarrow[R_1 \leftarrow R_1 - 500R_2]{R_1 \leftarrow R_1/1200} \left(\begin{array}{cc|c} 1 & 0 & \frac{1}{3600} \\ 0 & 1 & \frac{1}{3000} \end{array}\right) \tag{5}$$

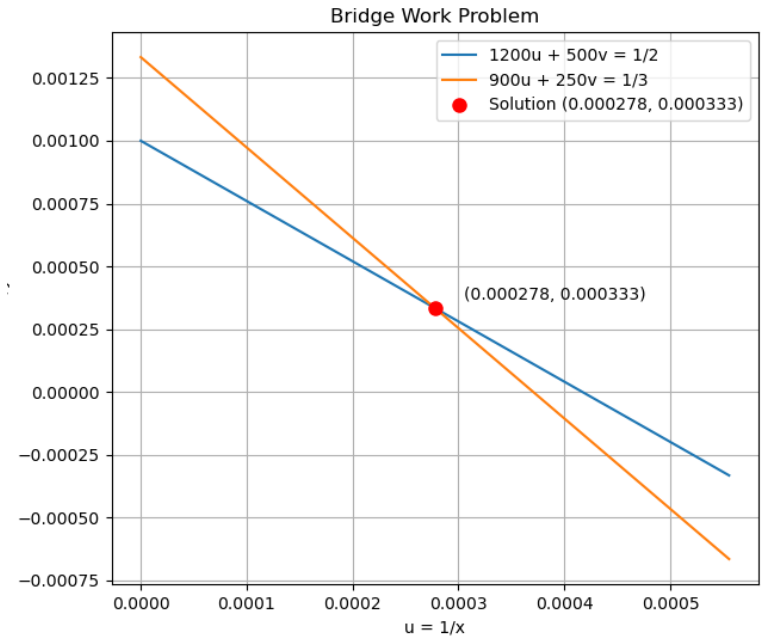
$$\begin{pmatrix} \frac{1}{x} \\ \frac{1}{y} \end{pmatrix} = \begin{pmatrix} \frac{1}{3600} \\ \frac{1}{3000} \end{pmatrix} \tag{6}$$

A man can finish the work in 3600 weeks; a woman can finish the work in 3000 weeks. Therefore 3600 men are required for completing the task in 1 week.

The theoretical solution can be verified from the following graph.

From the plot, $x = \frac{1}{u} = 3600$ and $y = \frac{1}{v} = 3000$

Plot


Bridge Work Problem
1200u + 500v = 1/2
900u + 250v = 1/3
Solution (0.000278, 0.000333)
(0.000278, 0.000333)
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
−0.00025
−0.00050
−0.00075
0.0000
0.0001
0.0002
0.0003
0.0004
0.0005
u = 1/x

C Code

```c
#include <stdio.h>

int solve_2x2(double A[4], double b[2], double x[2]) {
    double det = A[0]*A[3] - A[1]*A[2];

    if (det == 0.0) {
        return -1;
    }

    x[0] = (b[0]*A[3] - b[1]*A[1]) / det;
    x[1] = (A[0]*b[1] - A[2]*b[0]) / det;

    return 0;
}
```

Python + C Code

```
import numpy as np
import matplotlib.pyplot as plt
import ctypes
lib = ctypes.CDLL("./libcode.so")

lib.solve_2x2.argtypes = [ctypes.POINTER(ctypes.c_double),
                          ctypes.POINTER(ctypes.c_double),
                          ctypes.POINTER(ctypes.c_double)]
lib.solve_2x2.restype = ctypes.c_int


A = np.array([[1200, 500],
              [900, 250]], dtype=np.float64)
b = np.array([0.5, 1/3], dtype=np.float64)
```

Python + C Code

```
x = np.zeros(2, dtype=np.float64)

status = lib.solve_2x2(A.ctypes.data_as(ctypes.POINTER(ctypes.
    c_double)),
                       b.ctypes.data_as(ctypes.POINTER(ctypes.
                           c_double)),
                       x.ctypes.data_as(ctypes.POINTER(ctypes.
                           c_double)))

if status == 0:
    u, v = x
    man_weeks, woman_weeks = 1/u, 1/v
    men_required = round(man_weeks)

    print(f"One man finishes in {man_weeks:.0f} weeks")
    print(f"One woman finishes in {woman_weeks:.0f} weeks")
    print(f"Men required in 1 week: {men_required}")
```

Python + C Code

```
u_vals = np.linspace(0, u*2, 400)
v1 = (0.5 - 1200*u_vals) / 500
v2 = ((1/3) - 900*u_vals) / 250

plt.plot(u_vals, v1, label='1200u + 500v = 1/2')
plt.plot(u_vals, v2, label='900u + 250v = 1/3')

plt.plot(u, v, 'ro', label=f'({u:.6f}, {v:.6f})')
plt.annotate(f'({u:.6f}, {v:.6f})', xy=(u, v), xytext=(u*1.1,
     v*1.1))
plt.legend(); plt.grid(True)
plt.xlabel("u = 1/x"); plt.ylabel("v = 1/y")

plt.title("Bridge Work Problem")

plt.savefig("/mnt/c/Users/bharg/Documents/backupmatrix/
    ee25btech11013/matgeo/12.27/figs/Figure_1.png")
plt.show()
```

Python Code

```
import numpy as np
import matplotlib.pyplot as plt

A = np.array([[1200, 500],
              [900, 250]], dtype=float)

b = np.array([0.5, 1/3], dtype=float)

u, v = np.linalg.solve(A, b)

man_weeks = 1 / u
woman_weeks = 1 / v
men_required = round(man_weeks)

print(f"One man finishes in {man_weeks:.0f} weeks")
print(f"One woman finishes in {woman_weeks:.0f} weeks")
print(f"Men required in 1 week: {men_required}")
```

Python Code

```
u_vals = np.linspace(0, u*2, 400)
v1 = (0.5 - 1200*u_vals) / 500
v2 = ((1/3) - 900*u_vals) / 250

plt.figure(figsize=(7,6))
plt.plot(u_vals, v1, label='1200u + 500v = 1/2')
plt.plot(u_vals, v2, label='900u + 250v = 1/3')



plt.plot(u, v, 'ro', markersize=8, label=f'Solution ({u:.6f}, {v
    :.6f})')
plt.annotate(f'({u:.6f}, {v:.6f})', xy=(u, v), xytext=(u*1.1, v
    *1.1))

plt.xlabel("u = 1/x")
plt.ylabel("v = 1/y")
plt.title("Bridge Work Problem")
plt.legend()
plt.grid(True)
```