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Technological level: Advanced

Programming level: Mid

Technologies used: Python 3.10 | PyCharm | Linux | OpenOffice

Description of the problem: A ground station with a 4 m diameter parabolic antenna and an efficiency of 0.6 to which a signal of 100 W and a frequency of 14 GHz is fed radiates toward a satellite 40 000 km away. Determine the power received by the satellite antenna with a 3 dB main beam width of 2° and an efficiency of 0.55. Data: PT [dBW], η_T, f_u GHz, R [km], D_T [m], α_{3dB_R} [°], η_R.

Solution:

$$G_T = \eta_T \left(\frac{\pi D_T}{\lambda_u} \right)^2 = \eta_T \left(\frac{\pi D_T f_u}{c} \right)^2$$

$$G_R = \eta_R \left(\frac{\pi \cdot 70^o}{\alpha_{3\,dB_R}} \right)^2 = 0,55 \cdot \left(\frac{\pi \cdot 70^o}{2^o} \right)^2$$

$$L_{FS} = \left(\frac{4\pi R}{\lambda_u} \right)^2 = \left(\frac{4\pi R f_u}{c} \right)^2$$

$$P_{R[dBW]} = P_{T[dBW]} + G_{T[dBi]} + G_{R[dBi]} - L_{FS[dB]}$$

```
import math


class antena:


    def __init__(self, Pt, tetaT, fu, R, Dt, alfa3, tetar, c):
        self.Pt = Pt
        self.tetaT = tetaT
        self.fu = fu
        self.R = R
        self.Dt = Dt
        self.alfa3 = alfa3
        self.tetar = tetar
        self.c = c
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    def calculation(self):
       self.GT = round(10*math.log10((self.tetaT*math.pow((math.pi*self.Dt*self.fu*1e9/self.c), 2))), 2)
        self.GR = round(10*math.log10(self.tetar*math.pow((math.pi*70/self.alfa3), 2)), 2)
        self.LFS = round(10*math.log10( math.pow((4*math.pi*self.R*1e6*self.fu*1e9/self.c), 2)), 2)
        self.Pr_dBW = self.Pt+self.GT+self.GR-self.LFS
        return self.GT, self.GR, self.LFS, self.Pr_dBW


    def __str__(self):
        return f'{self.GT}, {self.GR}, {self.LFS}, {self.Pr_dBW}'



if __name__ == '__main__':
    ''' Data'''
    Pt = 20
    tetaT = 0.6
    fu = 14
    R = 40
    Dt = 4
    alfa3 = 2
    tetar = 0.55
    c = 3e8
    '''Calculation'''
    hear = antena(Pt, tetaT, fu, R, Dt, alfa3, tetar, c)
    print('GT:', hear.calculation()[0], 'dBi')
    print('GR:', hear.calculation()[1], 'dBi')
    print('LFS:', hear.calculation()[2], 'dBi')
    print('Power received by the antenna: ', hear.calculation()[3], 'dBW')
```

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GT: 53.15 dBi
GR: 38.23 dBi
LFS: 207.41 dBi
Power received by the antenna:  -96.03 dBW
```