Assignment: 2

1. Relevant data pertaining to a helicopter are given in the following.
   Weight of the helicopter: 36000 N

Density of air: ρ	1.225 Kg/m^3
Number of blades: N	4
Blade radius: R	6 m
Blade Chord: C	0.4 m
Profile drag coefficient:C_{d0}	0.01
Lift curve slope: a	5.73
Rotor angular rate:Ω	10π rad/sec
Tip loss factor: B	0.97
Root cut-out:	0.15 R

Blade twist for 4 different configurations: θ_{tw} = 0 deg,
-10 deg. (linear twist)
-20 deg. (linear twist)
Ideal twist with θ_{tip}

The helicopter is under hovering condition.

Assuming non-uniform inflow, evaluate the following and show each item in one figure:

i) Variation of pitch angle with non-dimensional radial location (all 4 twist cases in one figure)

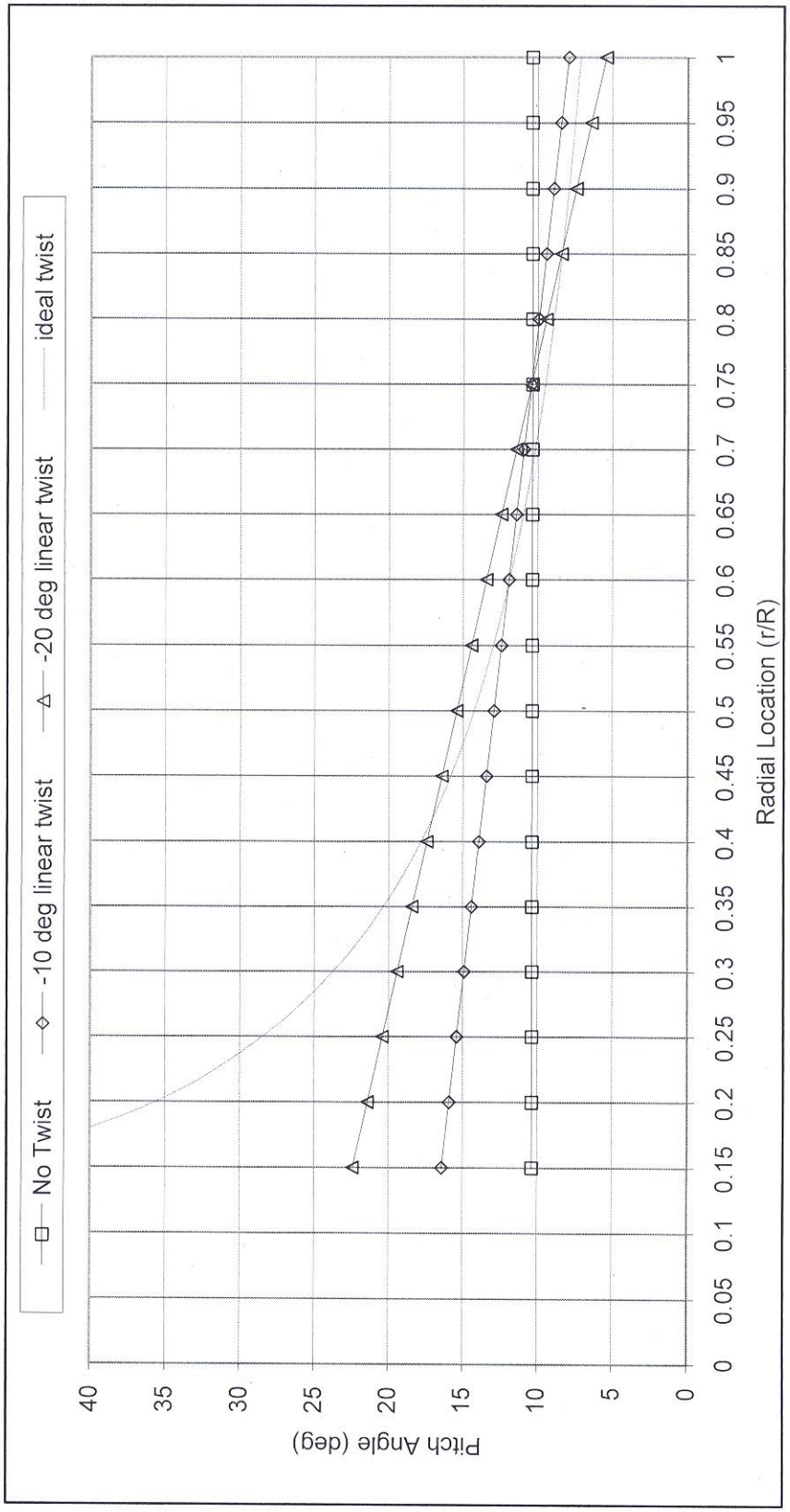
ii) Variation of angle of attack with non-dimensional radial location (all 4 twist cases in one figure)

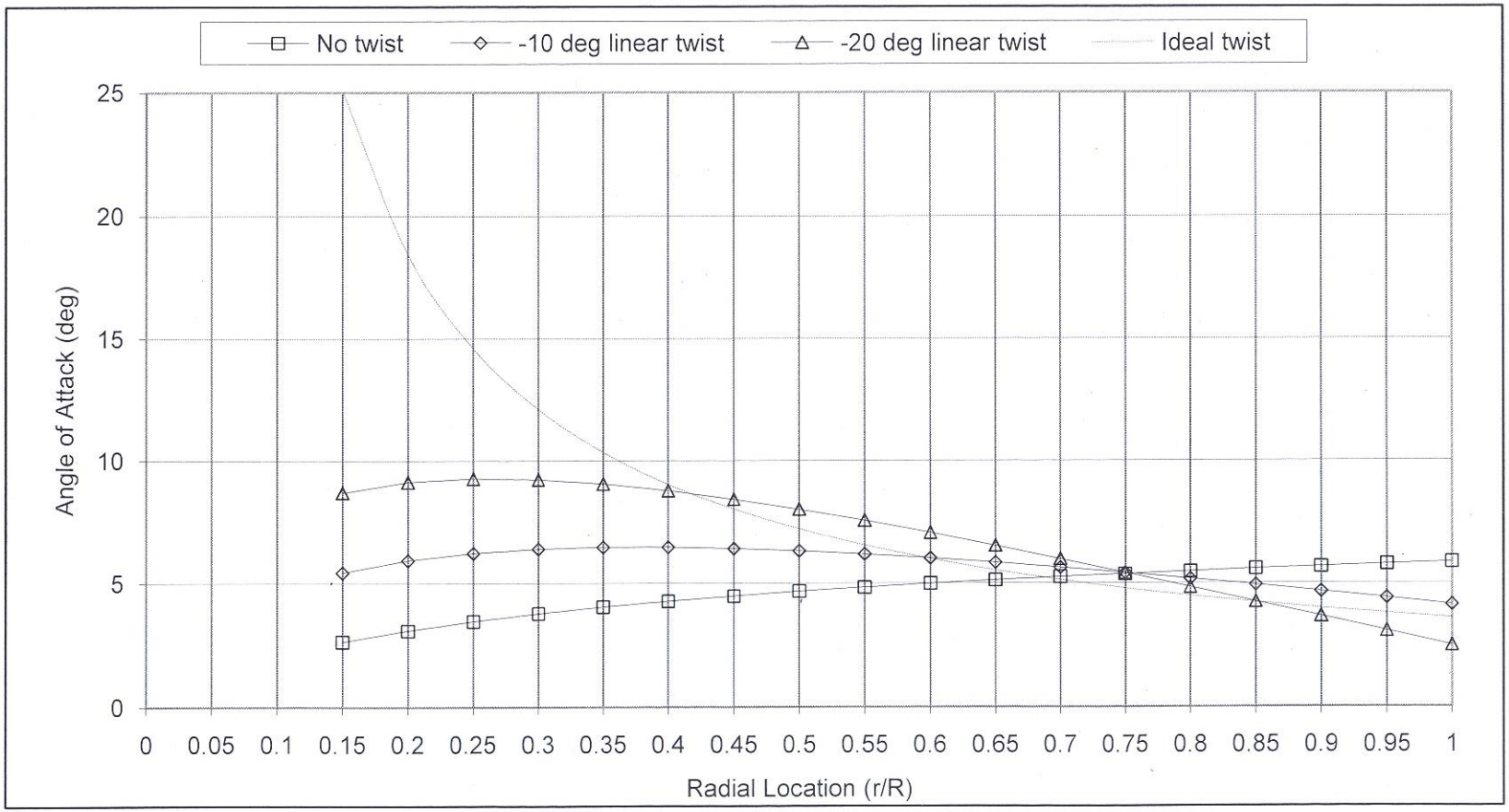
iii) Variation of induced velocity with non-dimensional radial location (all 4 twist cases in one figure)

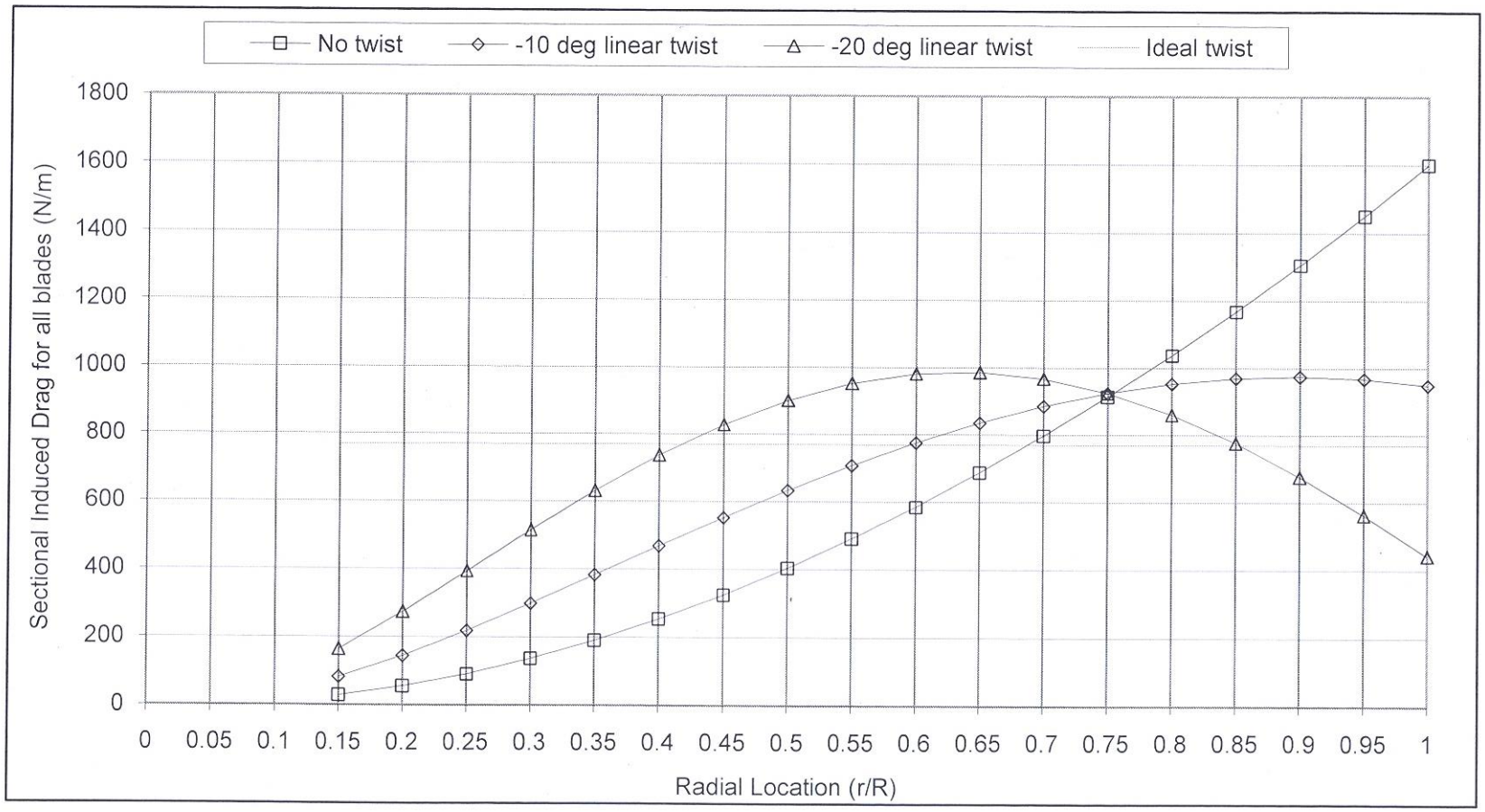
iv) Evaluate the Figure of Merit for each twist case. Assume κ=1.0

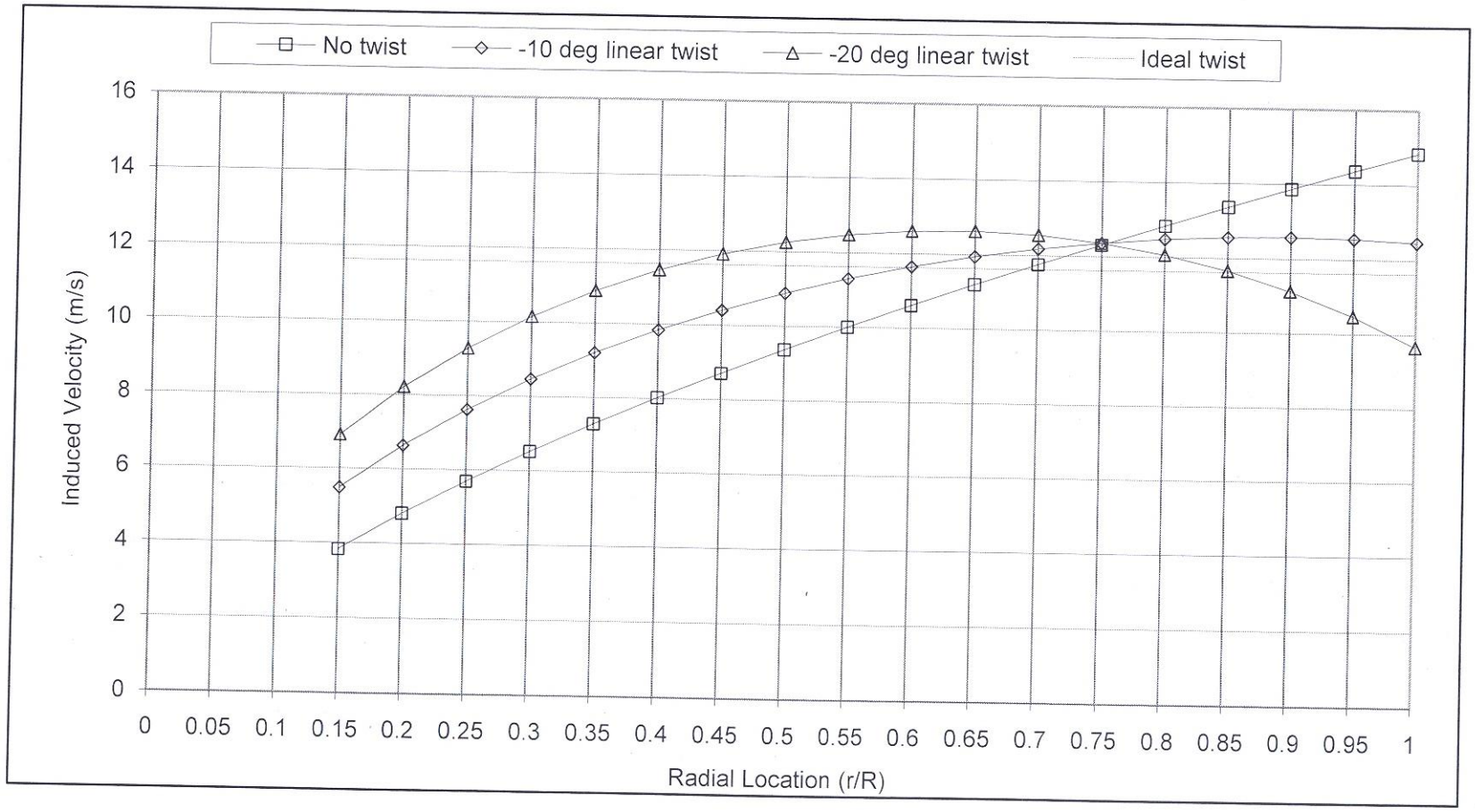
Note: Show the plots for non-dimensional radius from 0.15 to 1.0

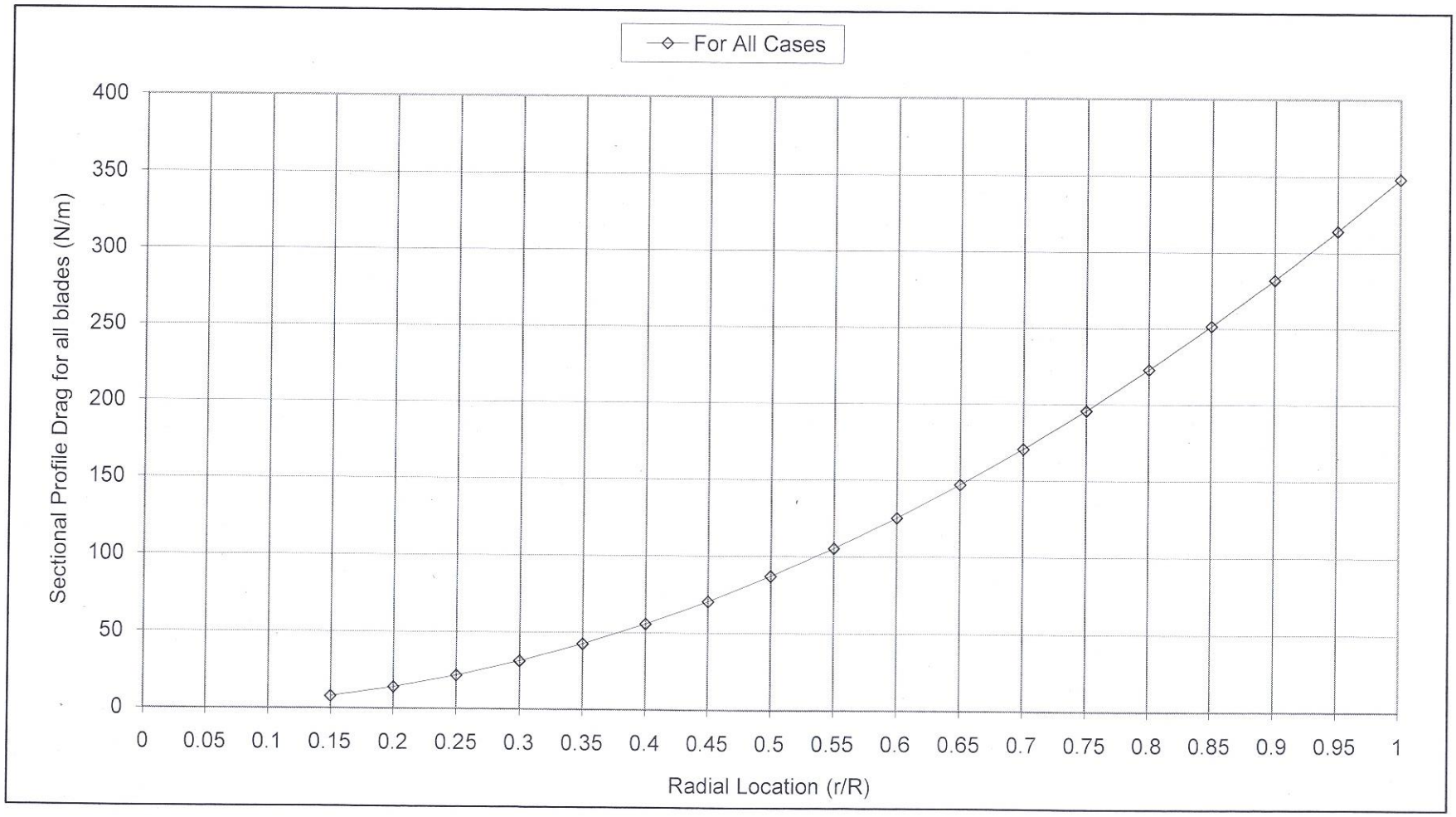
Solution:


No Twist
-10 deg linear twist
-20 deg linear twist
ideal twist
Pitch Angle (deg)
0
5
10
15
20
25
30
35
40
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7
0.75
0.8
0.85
0.9
0.95
1
Radial Location (r/R)


No twist
-10 deg linear twist
-20 deg linear twist
Ideal twist
Angle of Attack (deg)
25
20
15
10
5
0
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7
0.75
0.8
0.85
0.9
0.95
1
Radial Location (r/R)


No twist
-10 deg linear twist
-20 deg linear twist
Ideal twist
Sectional Induced Drag for all blades (N/m)
1800
1600
1400
1200
1000
800
600
400
200
0
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7
0.75
0.8
0.85
0.9
0.95
1
Radial Location (r/R)


No twist
-10 deg linear twist
-20 deg linear twist
Ideal twist
Induced Velocity (m/s)
16
14
12
10
8
6
4
2
0
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7
0.75
0.8
0.85
0.9
0.95
1
Radial Location (r/R)


For All Cases
Sectional Profile Drag for all blades (N/m)
400
350
300
250
200
150
100
50
0
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7
0.75
0.8
0.85
0.9
0.95
1
Radial Location (r/R)