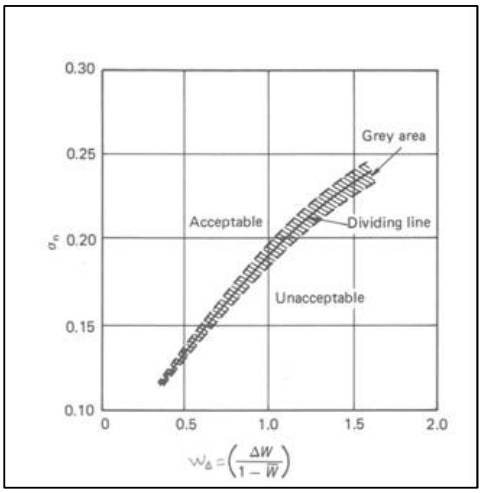
ADVANCED PROPULSION SYSTEM – MID-TERM EXAM
26/11/2004 - 14:00-15:00

1. Asses the quality of the wake given below according to the BMT's wake non-uniformity criteria (w_Δ, σ_{nI}) given in figure 1. (2**0 Points**)

Given:

D =3.6 m (propeller diameter)
N =140 (number of propeller revolution per minute - RPM)
Z = 4 (number of blades)
Zp = 2.15 m. (shaft height from the base line)
Ta = 6.0 m (Draft at the aft perpendicular)
Vapour pressure ($P_a - P_v$) = 100 000 N/m^2
ρ = 1025 kg/m^2. (Density of sea water)
g = 9.80665 m/sn^2. (Acceleration of gravity)



$$\sigma_{nI} = \frac{P_a - P_v + P_H}{\frac{1}{2}\rho(\pi n D)^2}$$

P_H = *Hydrostatic pressure at the propeller tip*

$$w_\Delta = \left(\frac{\Delta w}{1 - \overline{w}}\right)_{1.0R}$$

The wake is given in terms of the ***velocity ratio's*** method.

ANGLE	**AXIAL VELOCITY RATIO – V_x/V_s**							
0	0.200	0.303	0.362	0.369	0.387	0.423	0.430	0.448
10	0.200	0.303	0.367	0.361	0.360	0.391	0.416	0.458
20	0.182	0.276	0.314	0.276	0.274	0.334	0.388	0.462
30	0.153	0.233	0.248	0.198	0.211	0.305	0.398	0.513
40	0.130	0.199	0.209	0.175	0.214	0.337	0.456	0.598
50	0.119	0.183	0.210	0.208	0.281	0.425	0.546	0.687
60	0.120	0.182	0.238	0.275	0.383	0.540	0.645	0.760
70	0.124	0.188	0.274	0.348	0.484	0.650	0.734	0.811
80	0.128	0.193	0.306	0.410	0.564	0.731	0.799	0.843
90	0.134	0.200	0.333	0.458	0.617	0.778	0.839	0.863
100	0.142	0.211	0.361	0.500	0.654	0.799	0.861	0.878
110	0.153	0.228	0.391	0.541	0.685	0.811	0.873	0.890
120	0.166	0.247	0.419	0.578	0.714	0.824	0.883	0.900
130	0.172	0.257	0.432	0.597	0.733	0.837	0.891	0.904
140	0.168	0.251	0.418	0.582	0.726	0.839	0.891	0.902
150	0.156	0.234	0.380	0.532	0.684	0.813	0.875	0.895
160	0.152	0.228	0.345	0.471	0.617	0.758	0.839	0.890
170	0.170	0.256	0.350	0.439	0.562	0.702	0.801	0.891
180	0.182	0.274	0.362	0.420	0.543	0.712	0.814	0.899
r/R	**0.310**	**0.406**	**0.501**	**0.597**	**0.693**	**0.788**	**0.883**	**1.000**

Here 0 – Top dead center – 180 – bottom death center

Good Luck! Dr. Ali Can Takinacı

SOLUTION

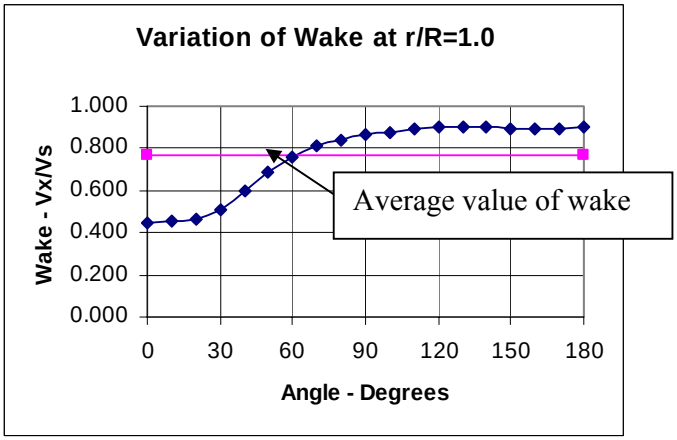
1. a) First calculate the parameter σ_{NI},

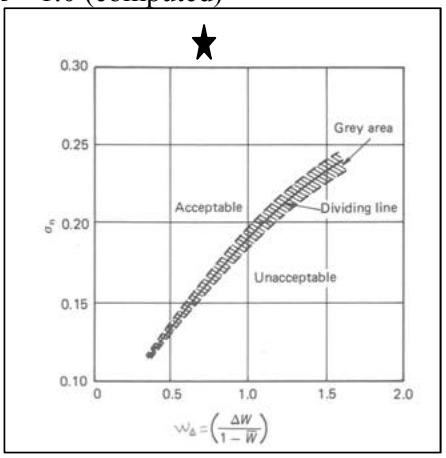
$$\sigma_{nI} = \frac{100000 + 9.80665 \times 1025 \times \left(6.000 - \frac{3.60}{2} - 2.15\right)}{\frac{1}{2} \times 1025 \times \left(\pi \times \frac{140}{60} \times 3.6\right)^2} = 0.338$$

Second calculate the wake parameter

$$w_\Delta = \left(\frac{\Delta w}{1 - \bar{w}}\right)_{1.0R} = \left(\frac{0.552 - 0.096}{1 - 0.232}\right)_{1.0R} = 0.593$$

0.552 (=1-0.448) is the max wake at the radius r/R = 1.0
0.096 (=1-0.904) is the min wake at the radius r/R = 1.0
0.232 (=1-0.768) is the average wake at the radius r/R = 1.0 (computed)





Vx/Vs	SM	Mult
0.448	1	0.448
0.458	4	1.832
0.462	2	0.924
0.513	4	2.052
0.598	2	1.196
0.687	4	2.748
0.760	2	1.520
0.811	4	3.244
0.843	2	1.686
0.863	4	3.452
0.878	2	1.756
0.890	4	3.560
0.900	2	1.800
0.904	4	3.616
0.902	2	1.804
0.895	4	3.580
0.890	2	1.780
0.891	4	3.564
0.899	1	0.899
	Sigma=	41.461
	Area=	2.412
	Mean=	0.768