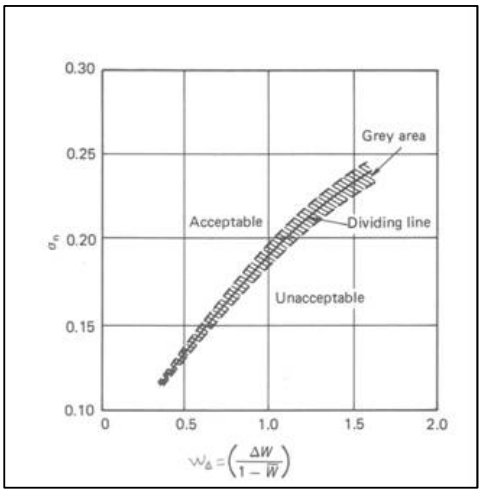
ADVANCED PROPULSION SYSTEM – MID-TERM EXAM
17/11/2006 - 14:00-15:00

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. (**15 Points**)

Given:

D =5.6 m (propeller diameter)
N =105 (number of propeller revolution per minute - RPM)
Z = 4 (number of blades)
Zp = 2.6 m. (shaft height from the base line)
Ta = 9.3 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*

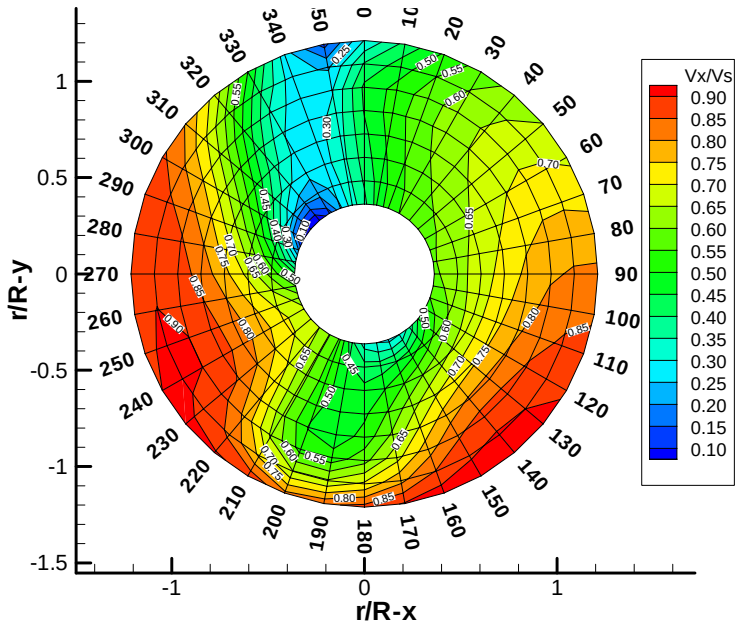
$$w_\Delta = \left(\frac{\Delta w}{1 - \overline{w}}\right)_{1.0R}$$

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

ANGLE	AXIAL VELOCITY RATIO – V_x/V_s							
0	0.350	0.339	0.343	0.360	0.389	0.392	0.343	0.224
10	0.439	0.425	0.414	0.403	0.393	0.419	0.401	0.357
20	0.460	0.457	0.462	0.475	0.494	0.523	0.513	0.481
30	0.515	0.486	0.476	0.493	0.528	0.567	0.575	0.566
40	0.583	0.511	0.469	0.471	0.507	0.563	0.594	0.619
50	0.637	0.526	0.451	0.435	0.472	0.546	0.601	0.658
60	0.671	0.531	0.429	0.395	0.439	0.532	0.610	0.694
70	0.693	0.533	0.407	0.355	0.409	0.523	0.624	0.732
80	0.712	0.535	0.388	0.318	0.377	0.511	0.635	0.766
90	0.728	0.539	0.377	0.291	0.348	0.497	0.639	0.790
100	0.734	0.542	0.376	0.284	0.333	0.485	0.637	0.801
110	0.722	0.542	0.388	0.302	0.340	0.482	0.635	0.802
120	0.697	0.540	0.410	0.339	0.366	0.487	0.636	0.803
130	0.669	0.536	0.431	0.376	0.391	0.490	0.640	0.810
140	0.652	0.534	0.440	0.388	0.392	0.475	0.637	0.822
150	0.648	0.527	0.426	0.363	0.357	0.436	0.615	0.820
160	0.633	0.502	0.387	0.311	0.303	0.384	0.567	0.774
170	0.595	0.457	0.338	0.260	0.264	0.345	0.499	0.669
180	0.637	0.466	0.306	0.197	0.194	0.294	0.427	0.572
r/R	**0.313**	**0.413**	**0.512**	**0.613**	**0.713**	**0.813**	**0.913**	**1.013**

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

2. The axial wake of a twin-screw product carrier is given below as equi-wake contour plot. Which direction of rotation for propeller should be preferred and why? (**5 Points**)



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

Good Luck! Dr. Ali Can Takinacı

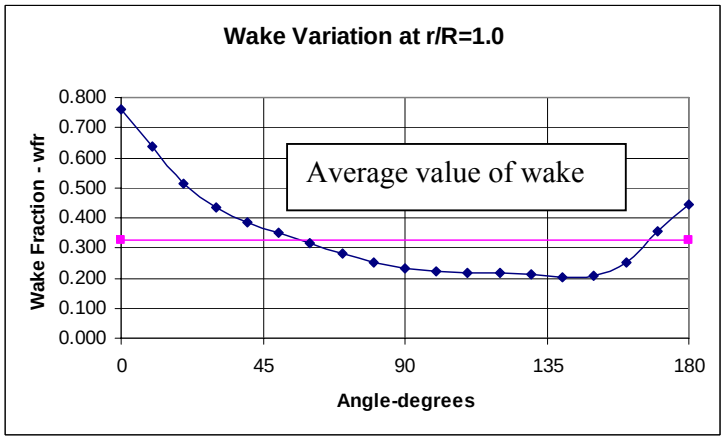
SOLUTION

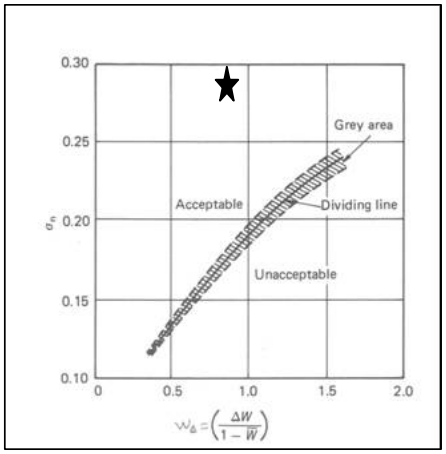
1. a) First calculate the parameter σ_{NI},

$$\sigma_{nI} = \frac{100000 + 9.80665 \times 1025 \times \left(9.300 - \frac{5.60}{2} - 2.600\right)}{\frac{1}{2} \times 1025 \times \left(\pi \times \frac{105}{60} \times 5.6\right)^2} = 0.287$$

Second calculate the wake parameter

$$w_\Delta = \left(\frac{\Delta w}{1 - \overline{w}}\right)_{1.0R} = \left(\frac{0.761 - 0.202}{1 - 0.326}\right)_{1.0R} = 0.829$$





ANGLE	w(1.0r)	SM	Mult.
0	0.761	1	0.761
10	0.637	4	2.549
20	0.515	2	1.030
30	0.433	4	1.731
40	0.384	2	0.769
50	0.349	4	1.398
60	0.317	2	0.634
70	0.282	4	1.128
80	0.251	2	0.502
90	0.230	4	0.919
100	0.220	2	0.441
110	0.220	4	0.879
120	0.219	2	0.437
130	0.212	4	0.848
140	0.202	2	0.404
150	0.207	4	0.827
160	0.253	2	0.506
170	0.353	4	1.412
180	0.447	1	0.447
		Sum=	17.620
		Area=	1.025

Mean =	0.326
Max=	0.761
Min=	0.202

2. The wake given is a typical form of twin screw and skeg. The direction of rotation should be selected from higher velocity region to slower one of wake. Therefore, for this wake, the direction of rotation of the propeller should be **inward turning**.