NAME 312 PROJECT – DUE DATE: FINAL EXAM DAY

SOLVE THE PROBLEMS GIVEN BELOW

THE PROPELLER IN "OPEN" WATER PART

1- A propeller of 3.0 m diameter and 0.8 pitch ratio absorbs its maximum delivered power when running at 180 rpm at a speed of advance of 13.5 knots. If the propeller torque remains constant, determine the propeller rpm, thrust and delivered power at speeds of advance of 0, 2.5, 5.0, 7.5 and 10.0 knots, using the data of Table 4.3.

2- A propeller is required to absorb a delivered power of 10000 kW at 150 rpm when advancing into open water at a speed of 10.0 m per sec. Determine the optimum diameter and pitch ratio of the propeller using the methodical series data given in Table 4.3. What is the thrust of the propeller?

Hint: Use excel sheets for "Propeller in Open Water" part of lecture notes.

$Z = 4$ $A_E/A_O = 0.500$

P/D:	0.5		0.6		0.7		0.8		0.9	
J	K_T	$10K_Q$	K_T	$10K_Q$	K_T	$10K_Q$	K_T	$10K_Q$	K_T	$10K_Q$
0	0.2044	0.1826	0.2517	0.2455	0.2974	0.3187	0.3415	0.4021	0.3840	0.4956
0.1	0.1795	0.1642	0.2254	0.2247	0.2702	0.2956	0.3114	0.3767	0.3567	0.4681
0.2	0.1499	0.1423	0.1949	0.2001	0.2393	0.2684	0.2831	0.3471	0.3263	0.4362
0.3	0.1156	0.1168	0.1603	0.1718	0.2047	0.2373	0.2489	0.3133	0.2929	0.3999
0.4	0.0765	0.0879	0.1215	0.1369	0.1665	0.2021	0.2115	0.2753	0.2564	0.3593
0.5	0.0327	0.0553	0.0786	0.1036	0.1246	0.1629	0.1707	0.2331	0.2169	0.3143
0.6	-	-	0.0315	0.0639	0.0790	0.1197	01266	0.1867	0.1743	0.2649
0.7	-	-	-	-	0.0297	0.0725	0.0792	0.1361	0.1287	0.2112
0.8	-	-	-	-	-	-	0.0284	0.0813	0.0800	0.1530
0.9	-	-	-	-	-	-	-	-	0.0283	0.0906
1.0	-	-	-	-	-	-	-	-	-	-

Table 4.3 (Contd.)

P/D	1.0		1.1		1.2		1.3		1.4	
J	K_T	$10K_Q$	K_T	$10K_Q$	K_T	$10K_Q$	K_T	$10K_Q$	K_T	$10K_Q$
0	0.4250	0.5994	0.4644	0.7133	0.5022	0.8374	0.5384	0.9717	0.5730	1.1161
0.1	0.3984	0.5698	0.4391	0.6818	0.4787	0.8040	0.5173	0.9366	0.5548	1.0794
0.2	0.3689	0.5357	0.4109	0.6456	0.4523	0.7659	0.4931	0.8967	0.5333	1.0378
0.3	0.3365	0.4971	0.3799	0.6048	0.4231	0.7231	0.4959	0.8520	0.5086	0.9915
0.4	0.3013	0.4540	0.3461	0.5594	0.3910	0.6757	0.4358	0.8026	0.4805	0.9403
0.5	0.2631	0.4064	0.3095	0.5094	0.3560	0.6234	0.4026	0.7484	0.4492	0.8843
0.6	0.2221	0.3543	0.2701	0.4548	0.3181	0.5665	0.3663	0.6894	0.4146	0.8235
0.7	0.1782	0.2976	0.2278	0.3955	0.2774	0.5049	0.3271	0.6257	0.3768	0.7579
0.8	0.1314	0.2365	0.1827	0.3317	0.2338	0.4385	0.2848	0.5571	0.3357	0.6875
0.9	0.0818	0.1708	0.1348	0.2632	0.1874	0.3675	0.2396	0.4839	0.2913	0.6122
1.0	0.0292	0.1007	0.0841	0.1900	0.1381	0.2917	0.1913	0.4058	0.2437	0.5322
1.1	-	-	0.0305	0.1123	0.0859	0.2113	0.1400	0.3229	0.1928	0.4474
1.2	-	-	-	-	0.0308	0.1261	0.0857	0.2353	0.1386	0.3577
1.3	-	-	-	-	-	-	0.0284	0.1429	0.0812	0.2632
1.4	-	-	-	-	-	-	-	-	0.0205	0.1640

THE PROPELLER "BEHIND" THE SHIP

1- A ship has a resistance of 500 kN at a speed of 16.0 knots with the engine producing a brake power of 6000 kW at 120 rpm. The propeller thrust is 600 kN and the loss of power in transmission from the engine to the propeller is 180 kW. In order to produce the same thrust at the same rpm in open water, the propeller would have to advance at a speed of 12.0 knots and require a torque of 500 kN m. Calculate the effective power, the thrust power and the delivered power, as well as the hull efficiency, the relative rotative efficiency, the open water efficiency and the propulsive efficiency (quasi-propulsive coefficient).

2- A ship has a speed of 20.0 knots when the propeller rpm is 180 and the brake power of the engine is 15000 kW. The effective power of the ship at 20.0 knots is 10000 kW, and the wake fraction is 0.200, the thrust deduction fraction 0.120 and the relative rotative efficiency 1.050, based on thrust identity. The shafting efficiency is 0.970. Calculate the delivered power and thrust power, the hull efficiency, propeller open water efficiency and propulsive efficiency, and the propeller thrust and torque.

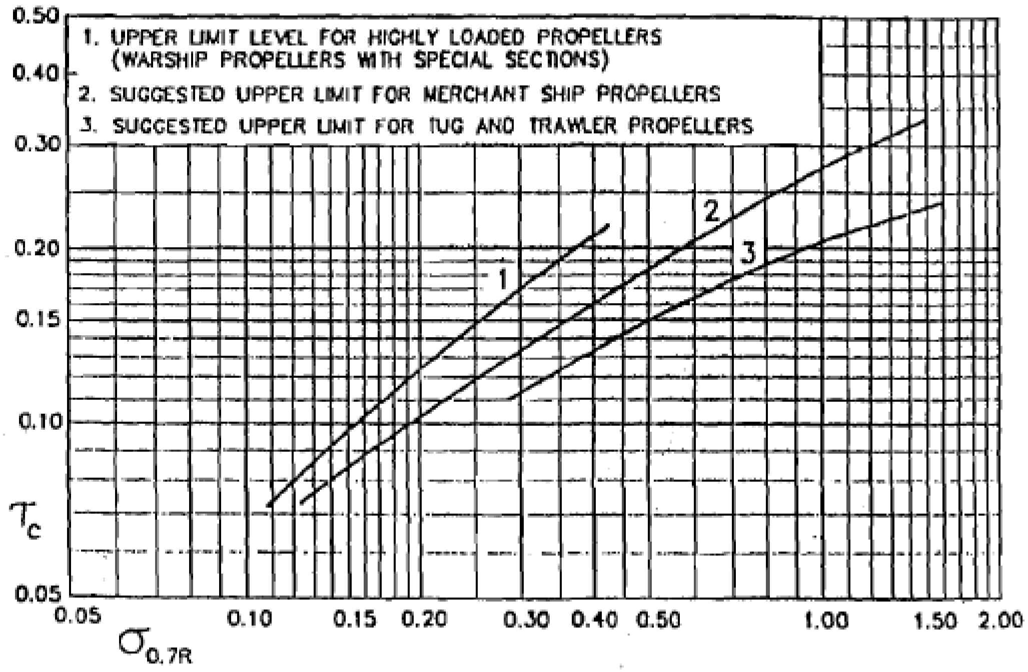
3- A twin screw ship has a design speed of 18.0 knots. Its propellers have a diameter of 3.0 m and are designed to operate at an advance coefficient $J = 0.7$. the corresponding open water thrust and torque coefficients being: $K_T = 0.350$, $10\,K_Q = 0.560$. The propulsion factors are: $w = 0.050$, $t = 0.060$, $\eta_R = 0.980$, $\eta_S = 0.960$. Determine the design propeller rpm and the brake power of each of the two engines. What is the effective power of the ship at the design speed?

PROPELLER CAVITATION

1- A propeller of diameter 4.0 m and pitch ratio 0.9 has an expanded blade area ratio of 0.500. The propeller axis is 2.5 m below the surface of water. As the propeller rpm is changed, the speed of the ship changes in such a way that the advance coefficient remains constant:

$$J = 0.500 \qquad K_T = 0.150 \qquad 10K_Q = 0.170$$

The wake fraction based on thrust identity is 0.250, the thrust deduction 0.200 and the relative rotative efficiency 1.050. Find the speed at which the propeller will begin to cavitate, and the corresponding effective power and delivered power. Use the Burrill criterion for merchant ships.



2- A single screw ship has a five-bladed propeller of 6.0 m diameter and 0.75 expanded blade area ratio with the propeller axis 5.0 m below the waterline. The effective power of the ship can be approximated by $P_E = 0.463\, V_K^{3.5}$ with P_E in kW and the ship speed V_K in knots. The thrust deduction fraction is

PROPELLER DESIGN

1- A twin-screw ship has two steam turbines each producing a shaft power of 11500 kW at 3000 rpm. The turbines are connected to the two three-bladed propellers through reduction gearing of ratio 12:1. The shafting efficiency is 0.940. The effective power of the ship is as follows:

Speed, knots :	30.0	32.0	34.0	36.0	38.0	40.0
Effective Power, kW :	9329	11693	14457	17658	21337	25533

The wake fraction, thrust deduction fraction and relative rotative efficiency based on thrust identity are 0.000, 0.050 and 0.990 respectively. The depth of immersion of the propeller axes is 3.2 m. Design the propellers using the Gawn Series data given in Problem 1 and the Burrill cavitation criterion for warship propellers.