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DESIGN OF SOFTWARE FOR CALCULATION AND ANALISYS ENGINE PROPELLER MATCHING

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ABSTRACT

Abstract-The criteria of a good ship are not only could floating in the sea, but it should have a very complex construction development planning. Longitudinal and transversal strengths, stability, flood, bulkhead, ship motion etc was interrelated criteria that should be calculated for safety and comfort of the ship, passenger and cargo passenger. Matching point is an operating point of rotation main engine (engine speed) such that match with the load character of propeller.In another word, the operating point of main engine rotation, where absorbed power by propeller is equal by produced power by main engine, and deliveringan equal speed with planned service speed. One step inship design evaluating is EPM (Engine Propeller Matching). The lack of available software to analyze relationship between characteristics of propeller with main engine and hull, causing the calculation of EPM (Engine Propeller Matching) takes more time. Java is a very popular application, especially for enterprise application. So that Java applications can be used to build a programming language of Engine Propeller Matching.

Keywords *: Engine propeller matching, programming language, Java.*

1.0 INTRODUCTION

An efficient shipusing main engine to generates power that is able to deliver a speed service as planned. Adji define match point is rotation main engine operating point where absorbed power by propeller is equal with produced power by main engine and generate an equal speed with planned speed service [2].

Information technology development resulted in computer capability increasing, that allows ship designingprocess can be done in a relatively short period. This was supported by software development to running a complete numerical analysis such as C++, Java, Vb.Net, Delphi, Fortran, Matlab and others. Steps of design related to one another makes it possible to create a program who have integrated for design so that the evaluation can performed simultaneously.

Java is a programming language for all requirements, concurrent, class-based, object-oriented and designed independently [3]. One of method in java language programming executes a block of statements repeatedly until the specified condition returns false. In general, statements are executed sequentially: The first statement in a function is executed, followed by the second, and so on.

Basicly, this study focused on how the combine method *for-loop* in java to find a *match point engine* and *propeller matching*.

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1.1 Engine Propeller Matching

In general, ships that move in fluid with a certain speed, it will make a resistance force opposite to the direction of ship movement. The amount of drag force that occurs should be able to be overcome by the thrust force of the ship generated from propeller. The power delivered to propeller from the Shaft Power, while the Shaft Power itself is sourced from the Brake Power (P) which is the output power of the ship's motor [2].

1.2 Characteristics of Hull Ships

One of the most influential stages in Engine Propeller Matching analysis process is the modeling stage of the ship's designed. This is because *Ship Body Characteristics* have a direct effect on the characteristics of the propeller. This ship's resistance is the inhibitory force of the fluid medium through which the vessel operates at a certain speed. The total inhibitory force is the sum of all components drag force working on the ship.

1.3 General Characteristics of Propellers in the Open Water Curve

Forces and moments produced by propellers can be described in the most basic form that is presented in a series of non- dimensional characteristics. This characteristic is used to describe in general the performance of a propeller. These characteristics are [2]:

Thrust Coefficient :

$$KT = \frac{T}{\rho n^2 D^4} \qquad (1)$$

Torque Advance Coefficient :

$$K_Q = \frac{Q}{\rho n^2 D^5} \qquad (2)$$

Coefficient :

$$J = \frac{Va}{n D} \qquad (3)$$

Cavitation number :

$$\sigma = \frac{P_0 - e}{\frac{1}{2}\rho V^2} \qquad (4)$$

Where :

D	=	Diameter of propeller
Va	=	Advanced velocity of fluid flow
n	=	Propeller rotary speed
ρ	=	Fluid density
P0 – e	=	Static pressure fluid around propeller

1.3 Hull and Propeller Interaction

Hull & Propeller Interaction is a approaches to obtain the performance characteristics of propeller for condition behind the ship. The method is by calculation as following (Carlton, 2007):

$$Tship = \frac{\alpha V_A{}^2}{(1-t)(1-w)^2} \qquad (5)$$

$$Tship = Tpropeller$$

$$Tpropeller = KT\ \rho\ n^2 D^4 \qquad (6)$$

$$KT = \frac{\alpha \, V_A{}^2}{\rho \; n^2 D^4 (1-t)(1-w)^2} \quad (7)$$

1.4 Java Programming Desktop

The Java programming language was originally created by James Gosling in 1995 as part of the Sun Microsystem Java Platform. Java syntax is much derived from C and C ++ but is simpler, tighter and has access to a more limited OS. This is because Java have intended as a programming language that is simple enough to learn and easy to read. The Java application is written as a *.java extension* that is compiled into file *.class*. This *.class* file is a byte code that works in all Java Virtual Machines, regardless of its OS or processor architecture. Java is a language intended for all needs, concurrent, class based, object oriented and designed to be independent of the environment in which the application is run [3].

2.0 DESIGN OF SISTEM

System was designed to obtain a match point between the hull, propeller and main engine. It's the point where power absorbed by propeller is equal to power produced by main engine and produces the ship speed approaching speed planned. The system of application can be seen in Figure 1. The data that have been collected will be processed, as for the stages in the data analysis include: Presentation of Ship Data**,** Steps of workmanship**,** Open water diagram readings**,** Calculation of total ship resistance, Calculation of power main engine**,** Propeller characteristics calculation, Engine rotation calculation, Load propeller calculation, Determination engine propeller matching and Engine graph propeller matching

3.0 METHOD

This study begins by entering the type of propeller into the database which will be used in this software. Database storage using Xamp™ and PHPmyadmin™. Coding process method *for-loop* java using NetBeans™. Result of running process can be seen in the Figure 1. *For-loop* method process contained in the *data input form*. The data will be *looping*are propeller-type, propeller diameter, and speed service. Figure 2 shows*data input form*.

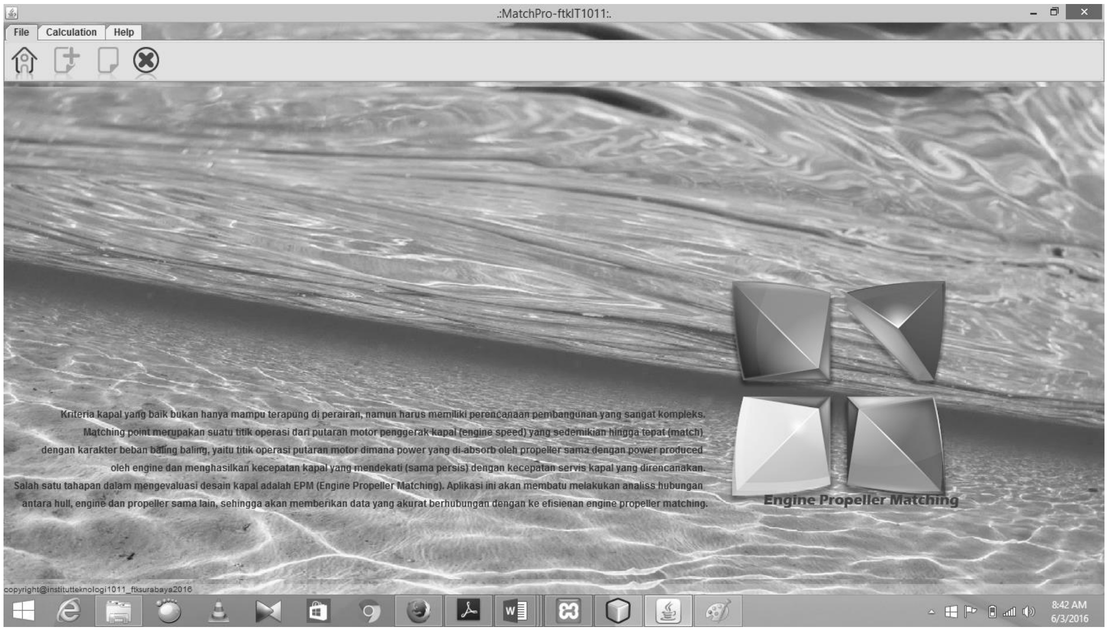


Figure 1: Main Form

4.0 TESTING APPLICATION / SOFTWARE

4.1 Data Collection

Testing application / software engine propeller matching begins input data dimensions of the ship and the selection of methods of calculation of ship resistance to be used. The steps can be seen in Figure 2.

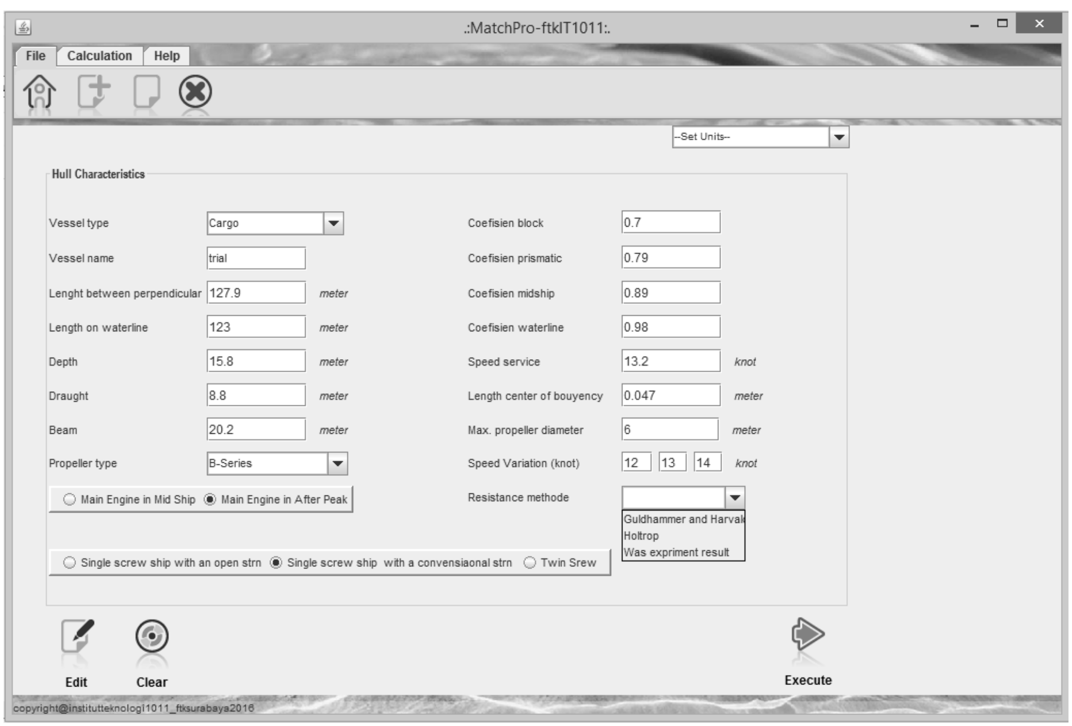


Figure 2. Form dimension of the ship and the selection of ship counting method of ship resistance.

The process of calculating the total resistance of the ship by the system is pressing execute button and will end with the main machine input form as shown in Figure 3.

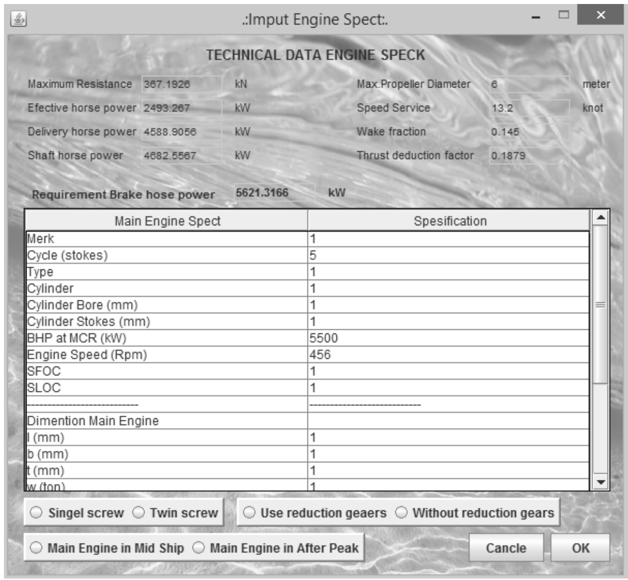


Figure 3. Machine input form

On the input form, machine will calculate the characteristics of the main engine to be used during the sailing vessel. The input form of this machine in addition to the characteristics of the engine that was also provided tables for input data gear reduction.

4.2 Output Testing Results Applications / software

Output of application / software testing results include:
The calculation of total ship resistance barriers. The total vessel barrier will be displayed by the application in the form of a table based on the variation of the speed covered in the input form. The results of the total ship resistance calculation can be seen in Figure 4.

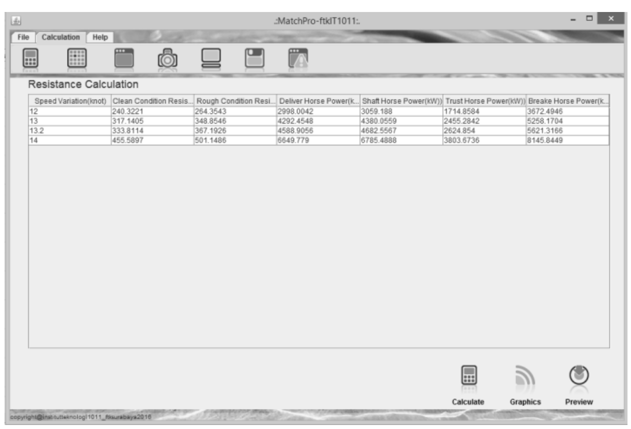
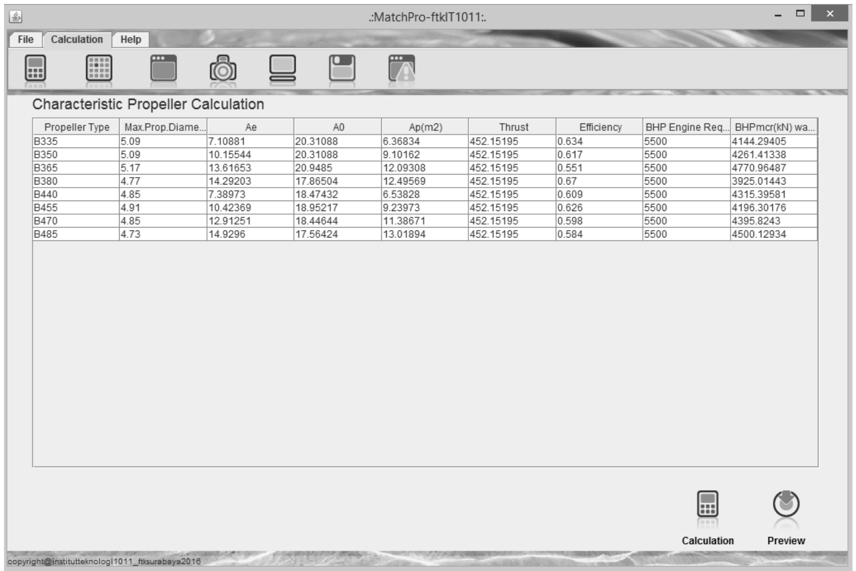


Figure 4. Form Calculation of total ship resistance

Calculation of propeller characteristics. In the form of propeller characteristics will show the type of propeller that can be installed on the ship. Database application provides 8 (eight) types of propeller type B-series that can be selected that is B335, B350, B365, B380, B440, B455, B470 and B485. The type of propeller to be displayed by the application is a non-cavitation propeller type, have a maximum diameter and has a power that is smaller than the main engine power at the time of operation at the speed service.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File | Calculation | Help

Characteristic Propeller Calculation

Propeller Type	Max.Prop.Diame...	Ae	A0	Ap(m2)	Thrust	Efficiency	BHP Engine Req...	BHPmcr(kN) wa...
B335	5.09	7.10881	20.31088	6.36834	452.15195	0.634	5500	4144.29405
B350	5.09	10.15544	20.31088	9.10162	452.15195	0.617	5500	4261.41338
B365	5.17	13.61653	20.9485	12.09308	452.15195	0.551	5500	4770.96487
B380	4.77	14.29203	17.86504	12.49569	452.15195	0.67	5500	3925.01443
B440	4.85	7.38973	18.47432	6.53828	452.15195	0.609	5500	4315.39581
B455	4.91	10.42369	18.95217	9.23973	452.15195	0.626	5500	4196.30176
B470	4.85	12.91251	18.44644	11.38671	452.15195	0.598	5500	4395.8243
B485	4.73	14.9296	17.56424	13.01894	452.15195	0.584	5500	4500.12934

Calculation
Preview

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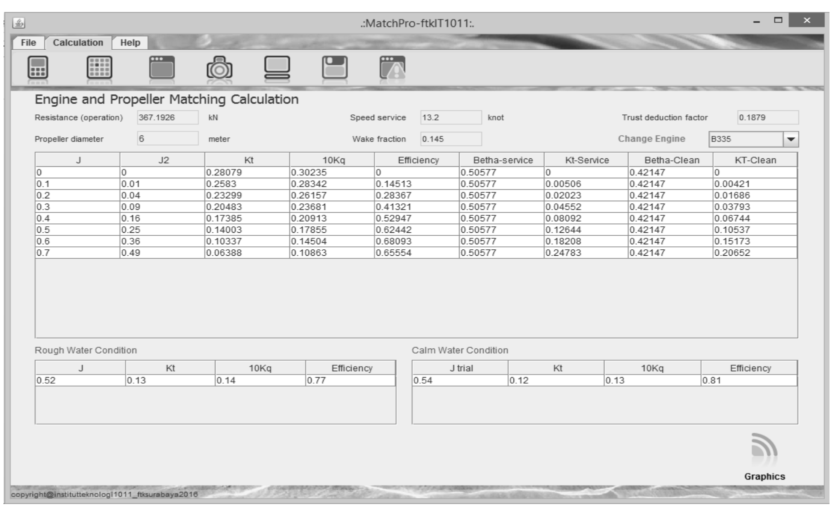
Figure 5. Form Caracteristic propeller

Engine and propeller matching calculation form displays a match at the operating point where operation of engine power rotation was absorbed by propeller same with power produced by the main engine. The result of bias calculation is seen in Figure 6.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Engine and Propeller Matching Calculation

Resistance (operation) 367.1926 kN
Speed service 13.2 knot
Trust deduction factor 0.1879
Propeller diameter 6 meter
Wake fraction 0.145
Change Engine B335

J	J2	Kt	10Kq	Efficiency	Betha-service	Kt-Service	Betha-Clean	KT-Clean
0	0	0.28079	0.30235	0	0.50577	0	0.42147	0
0.1	0.01	0.2583	0.28342	0.14513	0.50577	0.00506	0.42147	0.00421
0.2	0.04	0.23299	0.26157	0.28367	0.50577	0.02023	0.42147	0.01686
0.3	0.09	0.20483	0.23681	0.41321	0.50577	0.04552	0.42147	0.03793
0.4	0.16	0.17385	0.20913	0.52947	0.50577	0.08092	0.42147	0.06744
0.5	0.25	0.14003	0.17855	0.62442	0.50577	0.12644	0.42147	0.10537
0.6	0.36	0.10337	0.14504	0.68093	0.50577	0.18208	0.42147	0.15173
0.7	0.49	0.06388	0.10863	0.65554	0.50577	0.24783	0.42147	0.20652

Rough Water Condition

J	Kt	10Kq	Efficiency
0.52	0.13	0.14	0.77

Calm Water Condition

J trial	Kt	10Kq	Efficiency
0.54	0.12	0.13	0.81

Graphics

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Figure 6. Engine and propeller matching

Form the Engine and Propeller matching, there are graphics buttons displaying KT-KQ-J chart which will automatically determine the point J (advanced coefficient) which is the intersection between KT propeller and KT ship. The view of graphical can be seen in Figure 7.

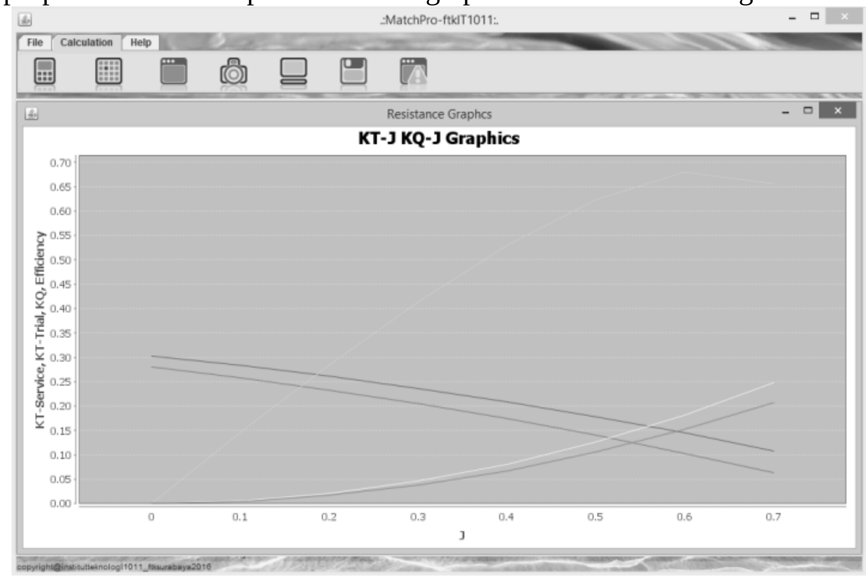

Figure 7. KT-KQ-J Graph Form

5.0 COMPARATIVE RESULT

To obtain the validation of the calculation results, then made a comparison of the calculations results. The following Table 1. Ship data that has been operating will be compared the results of its calculation the results of the calculation of the application compared with the results of the calculation of ships that have been operating.

Table 1 . Ship data

Ship Name	KM. Sungai 75
Ship type	Car ferries
Res. Method	Was experiment result
Propeller type	B-Series
Lwl	20.453 m
Lbp	18.95 m
H	2.7 m
T	1.9 m
B	8 m
Cb	0.6
Cm	0.929
Cw	0.9
V	11.22 knot
Lcb	-0.965
D	1 m

5.1 EHP Calculation

Result of comparison of EHP calculation can be seen in Table2 as follows:

Table 2. EHP Calculation

Speed (Knot)	Experiment	Software	Difference	Percentage
10.13	124.14152	131.3765	7.23	0.07
11.22	247.1784	232.8634	14.32	0.14
11.63	302.69488	320.3255	17.63	0.18
12	365.48036	386.6642	21.18	0.21

From the calculation result in Table2 the percentage difference in vessel service speed is 0.14%. This is due to differences in formulas used by the shipyard and application. Application gives a value of 1 + 20% Resistance on *sea margin*, while testing shipyard adds 15% EHP to get BHP on service condition.

5.2 Propeller Calculation

The result of comparison of propeller calculation can be seen in Table 3, as follows:

Table 3. Propeller Calculation

Calculation	Prop.Rps	Ae/A0	Eff (%)	Trust (kN)	Cavitation
Ship yard	10.6900	0.7000	0.5311	21.8390	No
Software	10.6909	0.6999	0.4600	28.3733	No
Difference	0.00070	0.0000	0.0711	6.53426	
	0.00000	0.00	0.0000	0.06534	

From the result of calculation of propeller in Table 3, the percentage of difference that is higher is in the trust generated by propeller that is reach 0.06%, while the rotation and propeller efficiency is close to 0%. Based on the calculation Propeller type B-470 can be used because of both calculations of shipyard and application does not occur cavitation.

6. CONCLUSION

Conclusion that can be taken from this research is as follows:

1. Application / software has been able to produce Match point between propeller and main engine mounted ship.
2. Using this application in the analysis of engine and propeller matching can reduce errors in manual readings.
3. This application can accelerate the calculation and analysis of engine and propeller matching in which 8 (eight) types of B-Series propellers can be calculated / running for ± 60 seconds.

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REFERENCES

Journal

1. H, Otto, Kristensen. 2012. *Prediction of Resistance and Propulsion Power Of Ships.* DTU.

Book

2. Adji, S.W., 2005. *Engine Propeller Matching.*ITS., Surabaya.
3. Bima.2003. Java Foundation.Ganesa.Bandung.
4. Carlton, JS.2007. Marine propellers and propulsion. Butterworth-Heinemann.
5. Harvald, Sv. Aa. 1992. *Tahanan dan Propulsi Kapal Edisi Terjemahan*. University Press. Airlangga . Surabaya.
6. Norwegian University of Science and Technology. 2012. Speed For Ships And Powering Prediction Model Based On Testing.

Thesis

7. Habibi. 2016. Pembuatan Aplikasi Engine Propeller Matching, Thesis, ITS, Surabaya.