



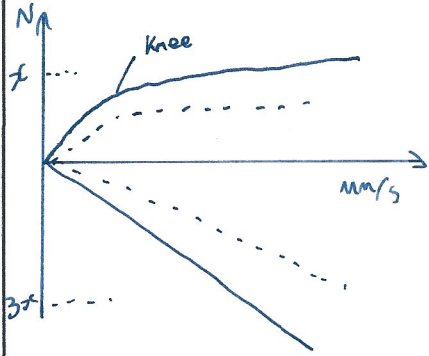
EXAMINATION SOLUTIONS : SESSION 2015/16

Programme:	BEng Motorcycle Engineering	Year:	Level 5
Module/Unit:	Motorcycle Dynamics		
Author:	Dr Owen Williams	Page:	1 of 3

Question No	Question	Marks
(1)	Comprehensive discussion of sensor deployment and analysis with respect to signal drop-out, filtering data loss, redundancy, logging frequencies and consequences to control systems if used.	5
(2)	Added systems would include inertial packs, gyroscope and multi axis accelerometer, torque sensors, GPS, CANBUS bike information from ECU, tyre temp etc... Key information is how the data is processed to aid the dynamic response of the bike. Eg. gyro data used to head lean angle so bike knows available grip and can control torque delivery	5
(3)	Calculation of V' to use to get forces in driver vector. This force used with $(N_f = m_f g - S_f)$ wheel load data to get suspension loads (using CoG and unsprung mass data) Suspension displacement then simply an application of Hooke's law (Vertical plane). finally resolved to real spring positions using $K_f = K \cos^2 \theta$ or $K_f = K \times L \cos^2$ Data shows how well suspension trace can be simulated and this gives a methodology to reverse engineer bike Specification to give information about suspension setup.	10

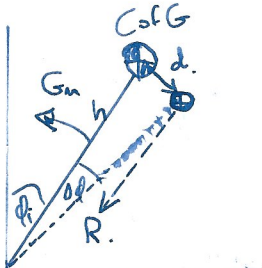
Continuation Sheet

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Question No	Question	Marks
(4)	Assume bike as half car model. Need to know ride frequencies for modern race bike and how to relate wheel rates to spring rates including link ratios and fork angles. The data allows calculation of all that is needed to give spring rates from $f = \frac{1}{2\pi} \sqrt{\frac{k}{m}}$. This gives k. Damping treated in a similar manner but based on specific chosen damping ratio for the bike. final answer should include front and rear spring rates and damping Coeff for basic compression / rebound analysis (Simplistic) for fork and shock unit.	15
(5)	 Better definition in compression damping between slow and mid speed (knee). Higher values for rebound. Even spread of data lines (settings) between solid and dashed line! Changes to compression setting should not have an effect on rebound and vice-versa. Better control of specific speed ranges (fast, mid and low) for both compression and rebound. Serviceability, ease of spring change (air release preload etc) and preload adjustment. Shiny gold packaging.	10

Continuation Sheet

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Question No	Question	Marks
6.	Comprehensive description of the operation of a gyroscope. Reference to $G_m = I\omega\Omega\cos\phi$ and Input/output axis for torque and precession. Can be described as a table top demonstration or as the front wheel of a motorcycle. Final description to include 'Countersteering' and the translation of applied torque at the bars to the roll rate of the front wheel which results in the vehicle roll rate.	5
7	 $G_m = I\omega\Omega\cos\phi$ $R = \sqrt{(mg)^2 + (mR\Omega^2)^2}$ Gyro torque $G_m = R \times d$ So $d = \frac{I\omega\Omega\cos\phi}{\sqrt{(mg)^2 + (mR\Omega^2)^2}}$ $\Delta\phi = \sin^{-1}\left(\frac{d}{h}\right)$	10
Total		60