**INSTRUCTIONS:**
**Fill out the hazard analysis and risk assessment below.**
**HA-001 should be for the lane departure warning function as discussed in the lecture.**
**HA-002 should be for the lane keeping assistance function as discussed in the lecture.**
**Then come up with your own situations and hazards for the lane assistance system. Fill in the HA-003 and HA-004 rows.**
**When finished, export your spreadsheet as a pdf file so that a reviewer can easily see your work.**

| Hazard ID | Situational Analysis | | | | | | | Hazard Identification | | | | | | Hazardous Event Classification | | | | | | Determination of ASIL and Safety Goals | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Operational Mode | Operational Scenario | Environmental Details | Situation Details | Other Details (optional) | Item Usage (function) | Situation Description | Function | Deviation | Deviation Details | Hazardous Event (resulting effect) | Event Details | Hazardous Event Description | Exposure (of situation) | Rationale (for exposure) | Severity (of potential harm) | Rationale (for severity) | Controllability (of hazardous event) | Rationale (for controllability) | ASIL Determination | Safety Goal |
| HA-001 | OM03 - Normal driving | OS04 - Highway | EN01 - Normal conditions | SD02 - High speed | | IU01 - Correctly used | Normal driving on Highway during rain (slippery conditions) with high speed and correctly used system | Lane Departure Warning (LDW) function shall apply an oscillating steering torque to provide the driver with haptic feedback | DV04 Actor effect is too much | The LDW function applies an oscillating torque with very high torque (above limit). | EV00 - Collision with other vehicle | High haptic feedback can affect driver's ability to steer as intended. The driver could lose control of the vehicle and collide with another vehicle or with road infrastructure. | The LDW function applies too high an oscillating torque to the steering wheel (above limit). | E3 - Medium probability | Driving On slippary Highway (because of rain) is very frequant in winter (or everyday in tropical weather) | S3 - Life-threatening or fatal injuries | Highway Speed limits are relativly high, and crashing on high speed is life-theatening | C3 - Difficult to control or uncontrollable | less than 90% of all drivers were able to avoid harm in that setuation | ASIL C | The oscillating torque from the Lane Departure Warning (LDW) function shall be limited. |
| HA-002 | OM03 - Normal driving | OS03 - Country Road | EN01 - Normal conditions | SD02 - High speed | | IU02 - Incorrectly used | Normal driving on country roads during normal conditions with high speed, the driver is misusing the lane keeping assistance function (as an autonomous function) | Lane Keeping Assistance (LKA) function shall apply the steering torque when active in order to stay in ego lane | DV03 Function always activated | the lane keeping assistance function is always activate | EV00 - Collision with other vehicle | lane keeping assistance was always on and had no time limit, driver hands may NOT be on the wheel at high speeds, a vehicle accident would not be controllable. | The lane keeping assistance function was NOT meant for fully autonomous driving. | E2 - Low probability | (on Highway with Highspeed + Misuse system) combination probably does not happen often | S3 - Life-threatening or fatal injuries | Crash on high speed is fatal | C3 - Difficult to control or uncontrollable | less than 90% of all drivers were able to avoid harm in that setuation | ASIL B | The lane keeping assistance function shall be time limited and the additional steering torque shall end after a given time interval so that the driver cannot misuse the system for autonomous driving. |
| HA-003 | OM03 - Normal driving | OS02 - City Road | EN07 - Snow (slippery road) | SD02 - High speed | | IU01 - Correctly used | Normal driving on City Road coverd with snow (slippery conditions) with low speed and correctly used system | Lane Departure Warning (LDW) function shall apply an oscillating steering torque to provide the driver with haptic feedback | DV11 - Actor effect is wrong | The LDW function applies false oscillating torque frequantly. | EV03 - Car spins out of control | lanes are not clear on icey road, which fires false LDWs | the LDW function applies wrong oscillating torque to steering wheel | E1 - Very low probability | once in a year or less. | S3 - Life-threatening or fatal injuries | on high speed, car crash is fataly harmful | C3 - Difficult to control or uncontrollable | less than 90% of drivers can control slippary car on icey road | ASIL A | The oscillating torque from the Lane Departure Warning (LDW) function shall stop when driver is trying to control the car in bad weather conditions. |
| HA-004 | OM03 - Normal driving | OS01 - Any Road | EN09 - N/A | SD06 - High braking | | IU01 - Correctly used | Normal driving on Any roads during Any conditions with high Braking, the driver correctly using the lane keeping assistance function. | Lane Keeping Assistance (LKA) function shall apply the steering torque when active in order to stay in ego lane | DV02 - Function unexpectedly activated | the lane keeping assistance function is NOT required in such situation | EV03 - Car spins out of control | lane keeping assistance tries to apply steering torque while Hard break, a vehicle accident would not be controllable. | The lane keeping assistance function is NOT required while Hard Breaking is performed | E3 - Medium probability | once a month or more, situation is frequant in chaotic cities and socities | S2 - Severe and life-threatening injuries | on Hard break, and sudden steering may flip the car, or cause a crash on low speed | C2 - Normally controllable | 90 % or more of all drivers or other traffic participants are usually able to avoid harm, we don't see cars flipping more often | ASIL A | The lane keeping assistance function shall be terminated when driver put his foot on the breaks. |

| Hazard ID | | HA-001 | HA-002 | HA-003 | HA-004 |
|---|---|---|---|---|---|
| Situational Analysis | Operational Mode | OM03 - Normal driving | OM03 - Normal driving | OM03 - Normal driving | OM03 - Normal driving |
| | Operational Scenario | OS04 - Highway | OS03 - Country Road | OS02 - City Road | OS01 - Any Road |
| | Environmental Details | EN01 - Normal conditions | EN01 - Normal conditions | EN07 - Snow (slippery road) | EN09 - N/A |
| | Situation Details | SD02 - High speed | SD02 - High speed | SD02 - High speed | SD06 - High braking |
| | Other Details (optional) | | | | |
| | Item Usage (function) | IU01 - Correctly used | IU02 - Incorrectly used | IU01 - Correctly used | IU01 - Correctly used |
| | Situation Description | Normal driving on Highway during rain (slippery conditions) with high speed and correctly used system | Normal driving on country roads during normal conditions with high speed, the driver is misusing the lane keeping assistance function (as an autonomous function) | Normal driving on City Road coverd with snow (slippery conditions) with low speed and correctly used system | Normal driving on Any roads during Any conditions with high Braking, the driver correctly using the lane keeping assistance function. |
| Hazard Identification | Function | Lane Departure Warning (LDW) function shall apply an oscillating steering torque to provide the driver with haptic feedback | Lane Keeping Assistance (LKA) function shall apply the steering torque when active in order to stay in ego lane | Lane Departure Warning (LDW) function shall apply an oscillating steering torque to provide the driver with haptic feedback | Lane Keeping Assistance (LKA) function shall apply the steering torque when active in order to stay in ego lane |
| | Deviation | DV04 Actor effect is too much | DV03 Function always activated | DV11 - Actor effect is wrong | DV02 - Function unexpectedly activated |
| | Deviation Details | The LDW function applies an oscillating torque with very high torque (above limit). | the lane keeping assistance function is always activate | The LDW function applies false oscillating torque frequantly. | the lane keeping assistance function is NOT required in such situation |
| | Hazardous Event (resulting effect) | EV00 - Collision with other vehicle | EV00 - Collision with other vehicle | EV03 - Car spins out of control | EV03 - Car spins out of control |
| | Event Details | High haptic feedback can affect driver's ability to steer as intended. The driver could lose control of the vehicle and collide with another vehicle or with road infrastructure. | lane keeping assistance was always on and had no time limit, driver hands may NOT be on the wheel at high speeds, a vehicle accident would not be controllable. | lanes are not clear on icey road, which fires false LDWs | lane keeping assistance tries to apply steering torque while Hard break, a vehicle accident would not be controllable. |
| | Hazardous Event Description | The LDW function applies too high an oscillating torque to the steering wheel (above limit). | The lane keeping assistance function was NOT meant for fully autonomous driving. | the LDW function applies wrong oscillating torque to steering wheel | The lane keeping assistance function is NOT required while Hard Breaking is performed |
| Hazardous Event Classification | Exposure (of situation) | E3 - Medium probability | E2 - Low probability | E1 - Very low probability | E3 - Medium probability |
| | Rationale (for exposure) | Driving On slippary Highway (because of rain) is very frequant in winter (or everyday in tropical weather) | (on Highway with Highspeed + Misuse system) combination probably does not happen often | once in a year or less. | once a month or more, situation is frequant in chaotic cities and socities |
| | Severity (of potential harm) | S3 - Life-threatening or fatal injuries | S3 - Life-threatening or fatal injuries | S3 - Life-threatening or fatal injuries | S2 - Severe and life-threatening injuries |
| | Rationale (for severity) | Highway Speed limits are relativly high, and crashing on high speed is life-theatening | Crash on high speed is fatal | on high speed, car crash is fataly harmful | on Hard break, and sudden steering may flip the car, or cause a crash on low speed |
| | Controllability (of hazardous event) | C3 - Difficult to control or uncontrollable | C3 - Difficult to control or uncontrollable | C3 - Difficult to control or uncontrollable | C2 - Normally controllable |
| | Rationale (for controllability) | less than 90% of all drivers were able to avoid harm in that setuation | less than 90% of all drivers were able to avoid harm in that setuation | less than 90% of drivers can control slippary car on icey road | 90 % or more of all drivers or other traffic participants are usually able to avoid harm, we don't see cars flipping more often |
| Determination of ASIL and Safety Goals | ASIL Determination | ASIL C | ASIL B | ASIL A | ASIL A |
| | Safety Goal | The oscillating torque from the Lane Departure Warning (LDW) function shall be limited. | The lane keeping assistance function shall be time limited and the additional steering torque shall end after a given time interval so that the driver cannot misuse the system for autonomous driving. | The oscillating torque from the Lane Departure Warning (LDW) function shall stop when driver is trying to control the car in bad weather conditions. | The lane keeping assistance function shall be terminated when driver put his foot on the breaks. |